

Special Publication No. 94-1

The Recreational Halibut Fishery in Southcentral Alaska (Area 3A) With 1993 Harvest Composition

A Report to the International Pacific Halibut Commission

by

Scott C. Meyer

September 1994

Alaska Department of Fish and Game

Division of Sport Fish



SPECIAL PUBLICATION NO. 94-1

THE RECREATIONAL HALIBUT FISHERY IN SOUTHCENTRAL ALASKA (AREA 3A)
WITH 1993 HARVEST COMPOSITION¹

A REPORT TO THE INTERNATIONAL PACIFIC HALIBUT COMMISSION

By

Scott C. Meyer

Alaska Department of Fish and Game
Division of Sport Fish
Anchorage, Alaska

September 1994

¹ This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-9, Job No. B-2-1.

The Special Publications series was established in 1991 for the publication of techniques and procedures manuals, informational pamphlets, symposia and workshop proceedings, application software documentation, in-house lectures, special subject reports to decision-making bodies, and other documents that do not fit in another publication series of the Division of Sport Fish. Special publications are intended for fishery and other technical professionals and lay persons. Distribution is to state and local publication distribution centers, libraries and individuals and, on request, to other libraries, agencies, and individuals. This publication has undergone editorial and peer review.

The Alaska Department of Fish and Game administers all programs and activities free from discrimination on the basis of sex, color, race, religion, national origin, age, marital status, pregnancy, parenthood, or disability. For information on alternative formats available for this and other department publications, contact the department ADA Coordinator at (voice) 907-465-4120, or (TDD) 907-465-3646. Any person who believes s/he has been discriminated against should write to: ADF&G, PO Box 25526, Juneau, AK 99802-5526; or O.E.O., U.S Department of the Interior, Washington, DC 20240.

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES.....	iii
LIST OF FIGURES.....	iv
LIST OF APPENDICES.....	vi
ABSTRACT.....	1
 PART ONE - RECREATIONAL FISHERY BACKGROUND	 2
IMPORTANCE OF THE HALIBUT FISHERY.....	2
FISHERY DESCRIPTIONS.....	6
Cook Inlet.....	6
Kodiak.....	10
North Gulf Coast.....	10
Prince William Sound.....	13
DATA SOURCES.....	13
Postal Survey.....	13
Port Sampling.....	15
HARVEST AND STOCK COMPOSITION.....	16
MANAGEMENT AND ALLOCATION ISSUES.....	17
 PART TWO - 1993 FISHERY STATISTICS	 20
GOALS AND OBJECTIVES.....	20
METHODS.....	20
Study Design.....	20
Biological Sampling.....	21
Angler Interviews.....	22
Parameter Estimation.....	23
Age, Length, and Sex Composition.....	23
Area, User Group, Target Species, and Gear	
Type Composition.....	25
Effects of a Bag Limit Reduction.....	26
Mean Length and Weight.....	26
Tests for Mean Length-at-Age.....	27
RESULTS.....	27

TABLE OF CONTENTS (Continued)

	<u>Page</u>
Age, Length, and Sex Composition.....	27
Age Composition.....	27
Length and Weight.....	30
Sex Composition.....	30
Geographic Distribution of Effort and Harvest.....	36
User Group, Target Species, and Gear Type Composition...	42
User Group Composition.....	42
Target Species Composition.....	42
Gear Type Composition.....	45
Effects of a Bag Limit Reduction.....	45
Tests for Differences in Mean Length-at-Age.....	45
 DISCUSSION.....	 50
 RECOMMENDATIONS.....	 52
 ACKNOWLEDGEMENTS.....	 52
 LITERATURE CITED.....	 53
 APPENDIX A.....	 57
 APPENDIX B.....	 61
 APPENDIX C.....	 63

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Estimated catch, harvest, and percent of catch released in the Area 3A recreational fishery, 1990-1992 (Mills 1991-1993).....	5
2. Number of halibut harvested in Cook Inlet recreational fisheries, 1977-1992 (Mills 1979-1993).....	7
3. Systematic sampling strata, sampling rates, and estimated proportions of the halibut harvest at Kodiak, Homer, Seward, and Valdez, 1993. Seward data are for the civilian fishery only, and do not include harvest at the Seward Military Recreation Camp.....	28
4. Length, net weight (eviscerated, head off), and round weight statistics for the 1993 recreational halibut harvest at Kodiak, Homer, Seward, and Valdez.....	31
5. Results of Anderson-Darling tests for differences in length composition among months and user groups, 1993..	33
6. Composition of recreational bottomfishing effort (angler-days) and halibut harvest (number of fish) by user group, southcentral Alaska, 1993.....	43
7. Composition of bottomfishing effort (angler-days) and halibut harvest (number of fish) by target species category, southcentral Alaska, 1993. Standard errors of percentages are shown in parentheses. Data are from interviews that included only anglers targeting bottomfish for all or part of their angler-day.....	44
8. Composition of bottomfishing effort (angler-days) and halibut harvest (number of fish) by terminal gear category, southcentral Alaska, 1993. Standard errors of percentages are shown in parentheses.....	46
9. Results of the two-factor analysis of variance test for differences among ports in mean length-at-age of male and female halibut harvested in the Area 3A recreational fishery, 1993.....	48

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Coastal waters and major ports of recreational halibut landings in IPHC Regulatory Area 3A.....	3
2. Estimated sport harvest of halibut, by fishery, in IPHC Regulatory Area 3A, 1977-1992 (Mills 1979-1993). The Cook Inlet fishery has accounted for 72%-83% of the Area 3A recreational harvest.....	4
3. Approximate areas fished in the Central and Lower Cook Inlet recreational halibut fisheries.....	8
4. Recreational halibut harvest by chartered and nonchartered anglers in Kenai Peninsula fisheries, 1986-1992 (Mills 1987-1993).....	9
5. Waters fished by the Kodiak-based recreational halibut fleet.....	11
6. North Gulf Coast waters fished by the Seward-based recreational halibut fleet.....	12
7. Prince William Sound and waters fished by recreational halibut fleets based in Whittier, Valdez, and Cordova..	14
8. Exploitable stock biomass and recruitment in IPHC Regulatory Area 3A, 1974-1991 (Sullivan 1993).....	18
9. Estimated age composition, by sex, of the recreational halibut harvest at Kodiak, Homer, Seward, and Valdez in 1993.....	29
10. Estimated cumulative length-frequency distributions of the recreational halibut harvest at Kodiak, Homer, Seward, and Valdez in 1993. Upper graphs show seasonal differences at each port and lower graph shows overall length composition at all ports.....	32
11. Estimated cumulative length-frequency distribution of the recreational halibut harvest by user group at Kodiak, Homer, Seward, and Valdez in 1993.....	34
12. Estimated relative proportions of male and female halibut in the recreational halibut harvest at Kodiak, Homer, Seward, and Valdez in 1993.....	35

LIST OF FIGURES (Continued)

<u>Figure</u>	<u>Page</u>
13. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Kodiak fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).....	37
14. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Homer fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).....	38
15. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Seward civilian fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).....	39
16. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Seward Military Recreation Camp charter fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).....	40
17. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Valdez fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).....	41
18. Estimated proportions of the recreational halibut harvest (in number of fish) made up of first and second fish in the bag limit at Kodiak, Homer, Seward, and Valdez in 1993. Graphs above the bold line show proportions by user group, while graphs below the bold line show overall proportions for each fishery.....	47
19. Mean length-at-age of male (top) and female (bottom) halibut harvested in recreational fisheries at Kodiak, Homer, Seward, and Valdez in 1993.....	49

LIST OF APPENDICES

<u>Appendix</u>	<u>Page</u>
A1. Estimated recreational fishing effort, by fishery, for all saltwater finfish in IPHC Regulatory Area 3A, 1979-1992 (Mills 1981a-1993).....	58
A2. Estimated recreational harvest of Pacific halibut, by fishery, in IPHC Regulatory Area 3A, 1977-1992 (Mills 1979-1993).....	59
A3. Estimation of recreational harvest biomass in IPHC Regulatory Area 3A, 1990-1992.....	60
B. Names and contents of 1993 halibut biological and interview data files archived with ADF&G, Division of Sport Fish, Anchorage.....	62
C1. Observed frequencies and proportions, by age class, of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1993.....	64
C2. Observed frequencies and proportions, by length class, of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1993. The total proportions by length class for Homer are weighted estimates (see Results section).....	66
C3. Observed frequencies and proportions (p) of female halibut harvested by sport anglers each month at Kodiak, Homer, Seward, and Valdez in 1993.....	68
C4. Observed number and estimated proportion (p) of angler-days fished and halibut harvested by fishery and ADF&G statistical area in southcentral Alaska, 1993.....	69

ABSTRACT

Pacific halibut *Hippoglossus stenolepis* is the primary bottomfish targeted by the saltwater recreational fishery in southcentral Alaska (International Pacific Halibut Commission Regulatory Area 3A). Area 3A harvests in recent years have made up 70% (in number) of the Alaska statewide recreational halibut harvest and 60% (in weight) of the recreational halibut harvest of the entire North American west coast. Recreational harvest in Area 3A grew from 18,000 fish in 1977 to 190,000 fish in 1992. Area 3A anglers released 31%-46% of the fish they caught during the period 1990-1992. Sport harvest estimates are based on a postal survey of resident and nonresident households; 1992 estimates had a relative precision of 3.5%. Since 1977 the Cook Inlet fishery has accounted for 72%-83% of the harvest in Area 3A. Growth in the Central Cook Inlet fishery has offset declines in the Lower Cook Inlet harvest since 1990. Age, size, and sex composition of the 1993 sport harvest were estimated at Kodiak, Homer, Seward, and Valdez. Ages ranged from 3 to 20 years, but 90% of the harvest was 5-14 years old ($n = 2,835$). The 1987 year class was strong at most ports. Most harvested fish were between 70 and 130 centimeters ($n = 3,577$). Mean lengths and weights were lowest at Seward (84.4 centimeters, 14.6 pound net) and highest at Homer (100.1 centimeters, 24.9 pound net). Halibut harvested by chartered anglers were larger than fish taken by unguided anglers at Homer, Seward, and Valdez. Mean length-at-age of harvested halibut was not significantly higher across all ages for any one port. Females made up 55% of the harvest at Seward and 80%-87% at other ports. Estimates of age, size, and sex composition were generally consistent with past years. Most of the Kodiak fleet fished within 20 kilometers of port, while fleets at other ports ranged up to 100 kilometers in search of halibut. Charter boats generally fished farther from port than private boats. Bait accounted for 67%-98% of the effort and 70%-99% of the harvest at the four ports. Institution of a one-fish daily bag limit would reduce harvest by approximately 26% at Kodiak, 45% at Homer, 30% at Seward, and 35% at Valdez.

KEY WORDS: Pacific halibut, *Hippoglossus stenolepis*, Kodiak, Homer, Seward, Valdez, southcentral Alaska, Chiniak Bay, Cook Inlet, Kachemak Bay, Resurrection Bay, Prince William Sound, Gulf of Alaska, recreational fishery, sport fishery, effort, harvest, harvest composition, stock composition, otolith, age, length, mean weight, sex composition, gear type, bag limit.

PART ONE - RECREATIONAL FISHERY BACKGROUND

IMPORTANCE OF THE HALIBUT FISHERY

Participation in recreational marine fisheries in southcentral Alaska has grown steadily over the last decade due to growth in the state's population and increased tourism. More anglers have also turned to marine fisheries as competition and restrictions on freshwater fishing opportunities increase. Recreational effort for all marine finfishes increased from about 200,000 angler-days in 1980 to 453,000 angler-days in 1992 in the area from Cape St. Elias westward through Bristol Bay (Appendix A1, Mills 1981b-1993). Cook Inlet fisheries accounted for about half of the effort during this period. In total, southcentral Alaska fisheries have accounted for about half of the statewide marine recreational fishing effort since 1980.

Pacific halibut *Hippoglossus stenolepis* (halibut hereafter) is a primary target of anglers in southcentral Alaska. The International Pacific Halibut Commission (IPHC) manages halibut stocks throughout the North Pacific and has divided the coast into 11 major regulatory areas. IPHC regulatory Area 3A encompasses most of southcentral Alaska and a small portion of southeast Alaska, extending from Cape Spencer westward to Cape Trinity on the southern end of Kodiak Island (Figure 1). Recreational halibut harvest in Area 3A has grown from about 18,000 fish in 1977 to 190,000 fish in 1992 (Figure 2, Appendix A2). Cook Inlet fisheries have traditionally dominated the Area 3A harvest, but most of the modest increase in the Area 3A harvest since 1990 has been due to growth in other fisheries. Anglers also release a large portion of their catch. An onsite creel survey estimated that 37% of halibut caught by the Valdez fleet in 1988 were released (Roth and Delaney 1989). Area 3A anglers also released an estimated 31%-46% of the halibut they caught during the period 1990-1992, or 86,000-153,000 fish per year (Table 1). Halibut made up 45% (in number) of the Area 3A finfish harvest in 1992 compared with 33% in 1987 (Mills 1988-1993).

The Area 3A recreational fishery is important on a statewide as well as coast-wide basis. Recent Area 3A sport harvests made up about 70% (in number) of the total Alaskan recreational halibut harvest (Appendix A2; Mills 1979-1993). On a larger scale, the 1992 sport harvest in Area 3A made up about 60% (by weight) of the entire recreational halibut harvest on the North American west coast.

The recreational halibut fishery is vital to the economy of southcentral Alaska. For example, sport anglers spent \$18.6 million to catch 85,200 halibut in Cook Inlet fisheries in 1986 (Jones and Stokes 1987). They also indicated a willingness to pay an additional \$25.2 million to ensure the continued availability of halibut fishing opportunities. Most port communities sponsor halibut derbies to attract anglers, and proceeds from derbies are often donated to support a wide variety of community projects and organizations (Denny 1990). Although there are no recent estimates of the economic value of the recreational fishery, it has undoubtedly increased concomitantly with effort and harvest.

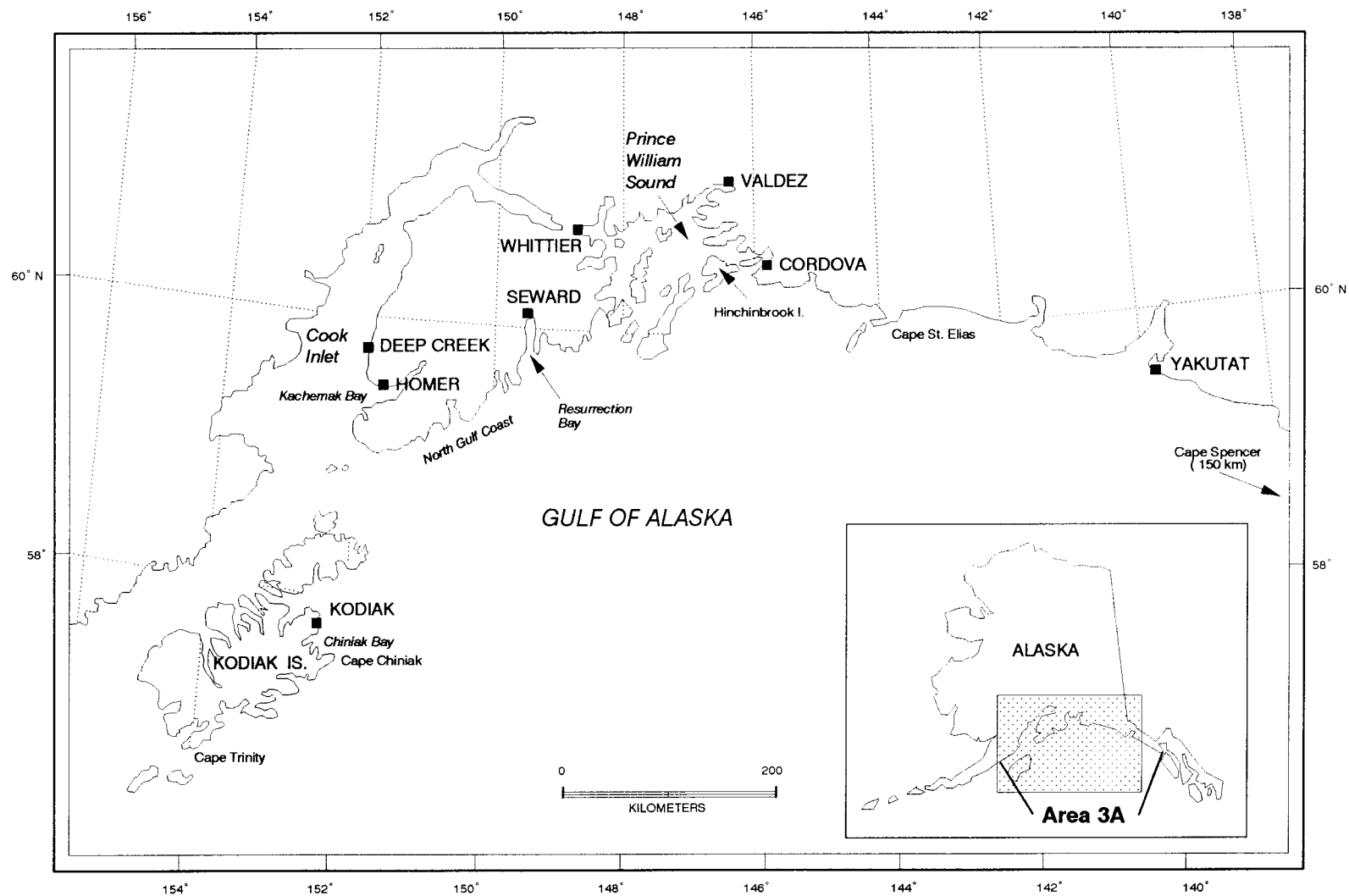


Figure 1. Coastal waters and major ports of recreational halibut landings in IPHC Regulatory Area 3A.

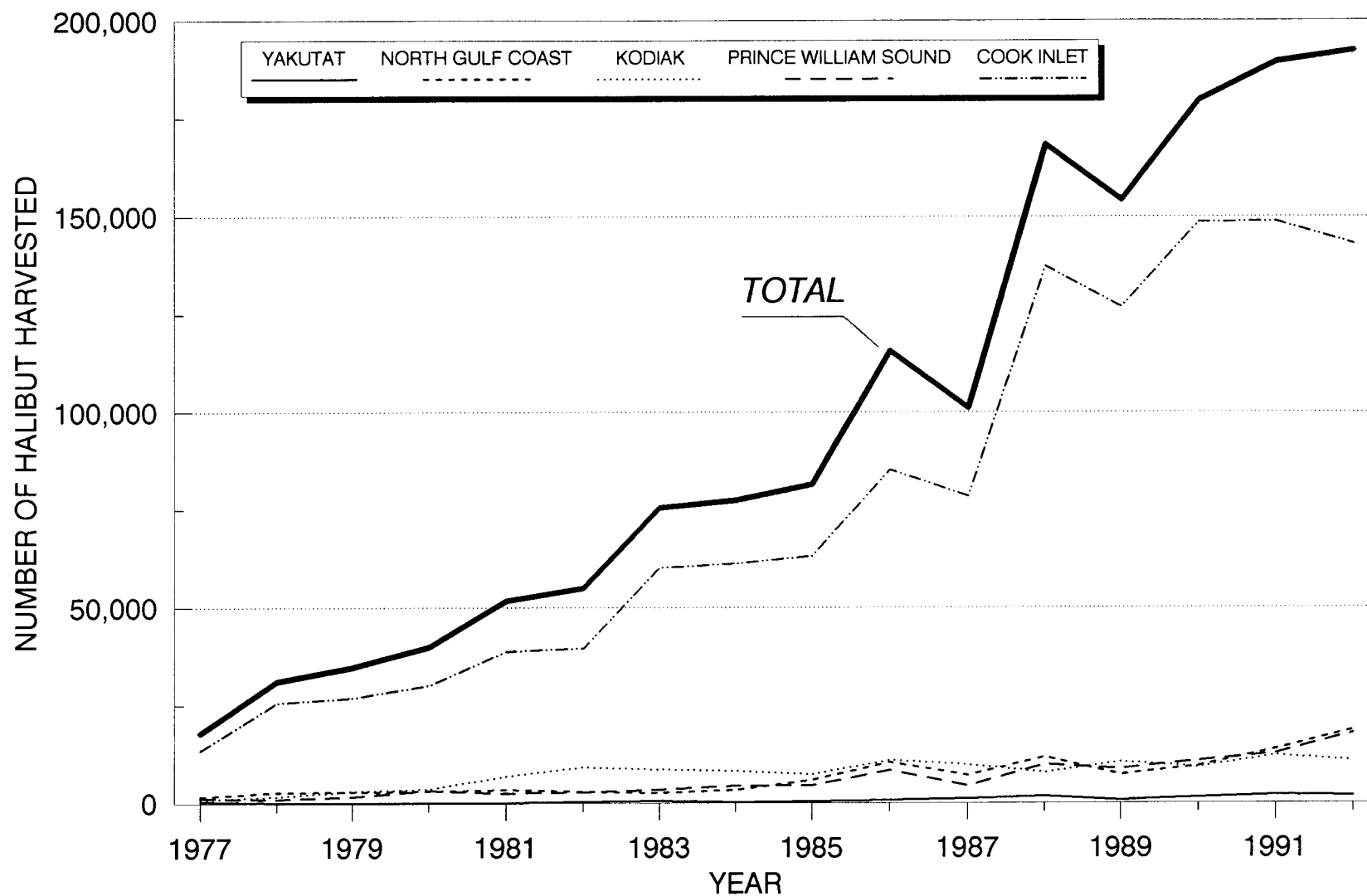


Figure 2. Estimated sport harvest of halibut, by fishery, in IPHC Regulatory Area 3A, 1977-1992 (Mills 1979-1993). The Cook Inlet fishery has accounted for 72%-83% of the Area 3A recreational harvest.

Table 1. Estimated catch, harvest, and percent of catch released in the Area 3A recreational fishery, 1990-1992 (Mills 1991-1993).

Year and Component	Number of Fish by Location					Total
	Cook Inlet ^a	Seward ^b	Kodiak ^c	PWS ^d	Yakutat ^e	
1990:						
Harvest	148,538	9,500	9,134	10,851	1,459	179,482
Release	132,288	6,810	7,712	8,046	593	155,449
Catch	280,826	16,310	16,846	18,897	2,052	334,931
% Released	47.1	41.8	45.8	42.6	28.9	46.4
1991:						
Harvest	148,646	13,818	12,089	12,733	2,112	189,398
Release	72,397	3,448	6,668	5,036	455	88,004
Catch	221,043	17,266	18,757	17,769	2,567	277,402
% Released	32.8	20.0	35.5	28.3	17.7	31.7
1992:						
Harvest	143,094	18,595	10,860	17,855	1,861	192,265
Release	113,383	9,942	9,356	9,656	736	143,073
Catch	256,477	28,537	20,216	27,511	2,597	335,338
% Released	44.2	34.8	46.3	35.1	28.3	42.7

^a Cook Inlet: waters north of a line from Gore Point to Cape Douglas.

^b Seward: all waters from Gore Point east to Cape Puget.

^c Kodiak: waters surrounding the Kodiak and Afognak Island groups, including the Barren and Trinity Islands.

^d Prince William Sound: waters between Cape Suckling and Cape Puget.

^e Yakutat: Yakutat Bay and adjacent Gulf of Alaska waters.

The charter boat industry is an important economic component of the recreational fishery. For example, the Homer halibut charter boat industry generated \$9.1 million in gross income for the Homer economy as well as an equivalent of 64 full-time, year-round jobs in 1985 (Coughenower 1986). Fifty-eight percent of the chartered anglers in Homer were Alaska residents in 1985. Two-thirds of chartered anglers surveyed said they would not have come to Homer if charter services had not been available.

FISHERY DESCRIPTIONS

Regulatory Area 3A is composed of many regional and local fisheries that are conducted in more or less separate geographic areas and possess distinctive patterns of harvest and use. The vast majority of harvest is taken in four major fisheries: Cook Inlet, Kodiak, the North Gulf Coast, and Prince William Sound (Figure 1). A local fishery based in Yakutat harvests an insignificant number of fish and will not be described in detail in this report.

Cook Inlet

The Cook Inlet fishery is the largest recreational halibut fishery in North America and has grown rapidly. Since 1977, the Cook Inlet fishery has accounted for 72%-83% (in number) of the Area 3A recreational harvest. The 1992 Cook Inlet harvest made up about 73% (by weight) of the Area 3A harvest (Appendix A3) and 44% (by weight) of the entire North American sport harvest of halibut. Estimated harvest increased from 13,500 fish in 1977 to over 143,000 fish in 1992 (Table 2).

The Cook Inlet halibut fishery can be conveniently divided into two areas: (1) Central Cook Inlet (CCI), consisting of waters south of the West Foreland and north of the latitude of Anchor Point; and (2) Lower Cook Inlet (LCI), consisting of waters south of Anchor Point and north of a line from Cape Douglas to Gore Point (Figure 3). Major access points in CCI include boat ramps and beach launch sites at Deep Creek, Ninilchik and Anchor Point. Boats that launch in CCI generally fish the eastern half of Cook Inlet north of Anchor Point. Halibut are rarely caught north of the mouth of Kenai River. The primary access point for the LCI fishery is Homer, with a few boats also launching at Seldovia and other communities on the south side of Kachemak Bay. Boats based out of Homer fish primarily south of Anchor Point (Meyer 1992, p. 49; and 1993b p. 27) but may range south of the Barren Islands and as far east as Port Dick.

Recent growth in the CCI fishery has offset declines in the LCI fishery. Harvest in CCI has increased every year since 1987, while LCI harvest has been stable or decreasing since 1988 (Figure 4). Most of the increase in CCI has been due to a rapidly expanding charter fleet, particularly at Deep Creek. Until recently the Deep Creek fishery had been dominated by unguided anglers. Harvest by chartered anglers increased from 3% in 1986 to 41% in 1992 in CCI. In contrast, the proportion of harvest taken by chartered anglers has remained relatively stable at 50%-68% in LCI. The number of bottomfish charter boats active at any level is estimated at 120-130 in LCI and 220-250 in CCI. This includes boats that spend only a portion of the day targeting halibut, as well as boats operated on a "full-time" (120 days or more per year) and "part-time" (less than 120 days per year) basis.

Table 2. Number of halibut harvested in Cook Inlet recreational fisheries, 1977-1992 (Mills 1979-1993).

Year	Lower Cook Inlet ^a	Central Cook Inlet ^a	West Cook Inlet ^a	Total Cook Inlet	Percent of Area 3A
1977	9,416	4,050	-	13,466	75.5
1978	20,756	4,821	-	25,577	82.6
1979	20,479	6,518	-	26,997	77.8
1980	21,808	8,177	-	29,985	75.3
1981	29,294	9,427	-	38,721	75.1
1982	28,851	10,681	-	39,532	72.1
1983	36,623	23,503	-	60,126	79.7
1984	37,747	23,455	-	61,202	79.2
1985	41,450	21,198	510	63,158	77.5
1986	44,250	39,831	1,072	85,153	73.6
1987	45,707	31,855	869	78,431	77.6
1988	93,878	42,182	1,192	137,252	81.6
1989	76,606	49,087	1,224	126,917	82.4
1990	93,941	52,912	1,685	148,538	82.8
1991	89,998	57,072	1,576	148,646	78.5
1992	81,451	60,659	984	143,094	74.4

^a Estimates for Lower Cook Inlet and Central Cook Inlet were obtained by summing postal survey estimates by site as defined in the text. West Cook Inlet estimates include fish that could not be assigned to the other two areas. No halibut harvest was reported in West Cook Inlet until 1985.

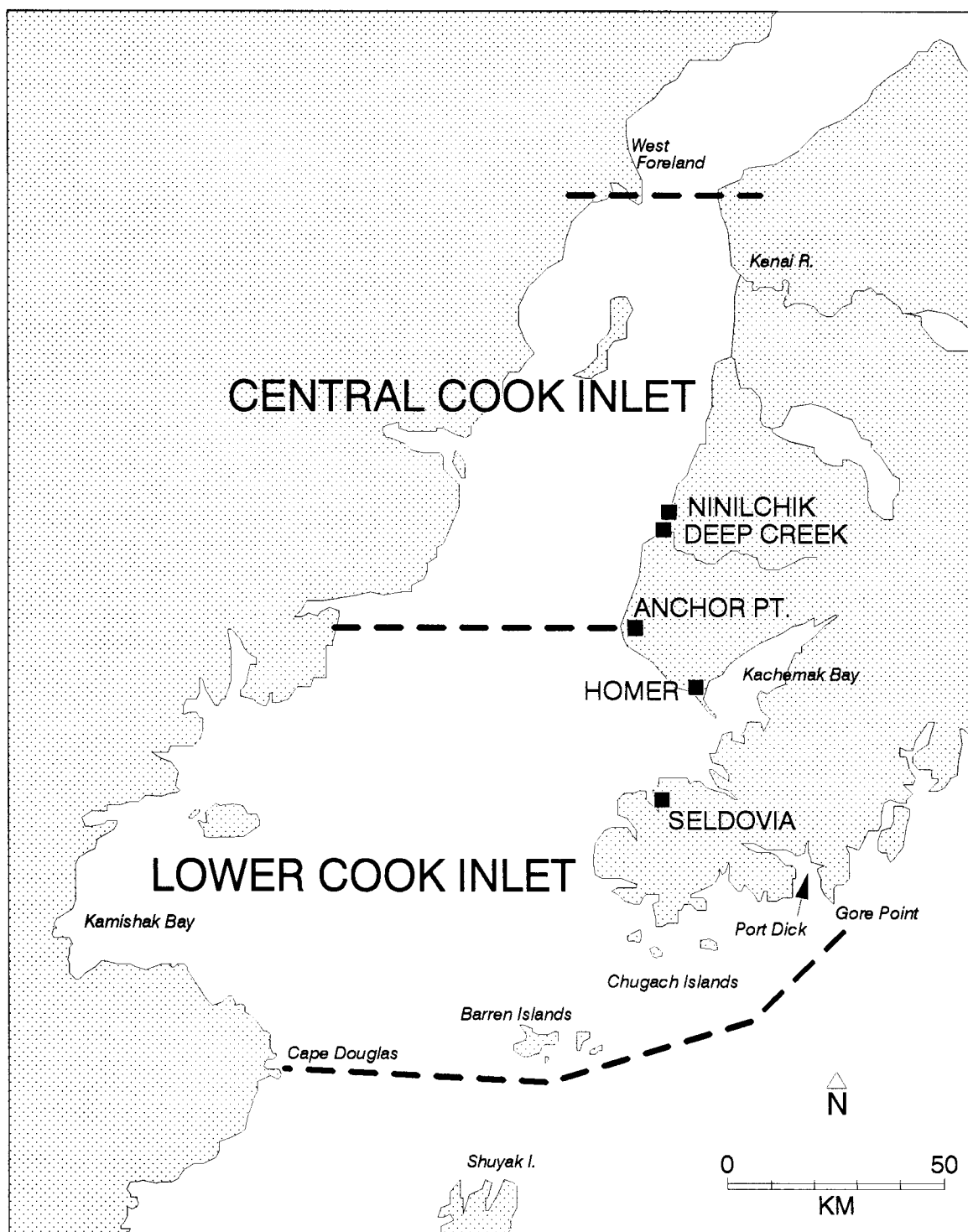


Figure 3. Approximate areas fished in the Central and Lower Cook Inlet recreational halibut fisheries.

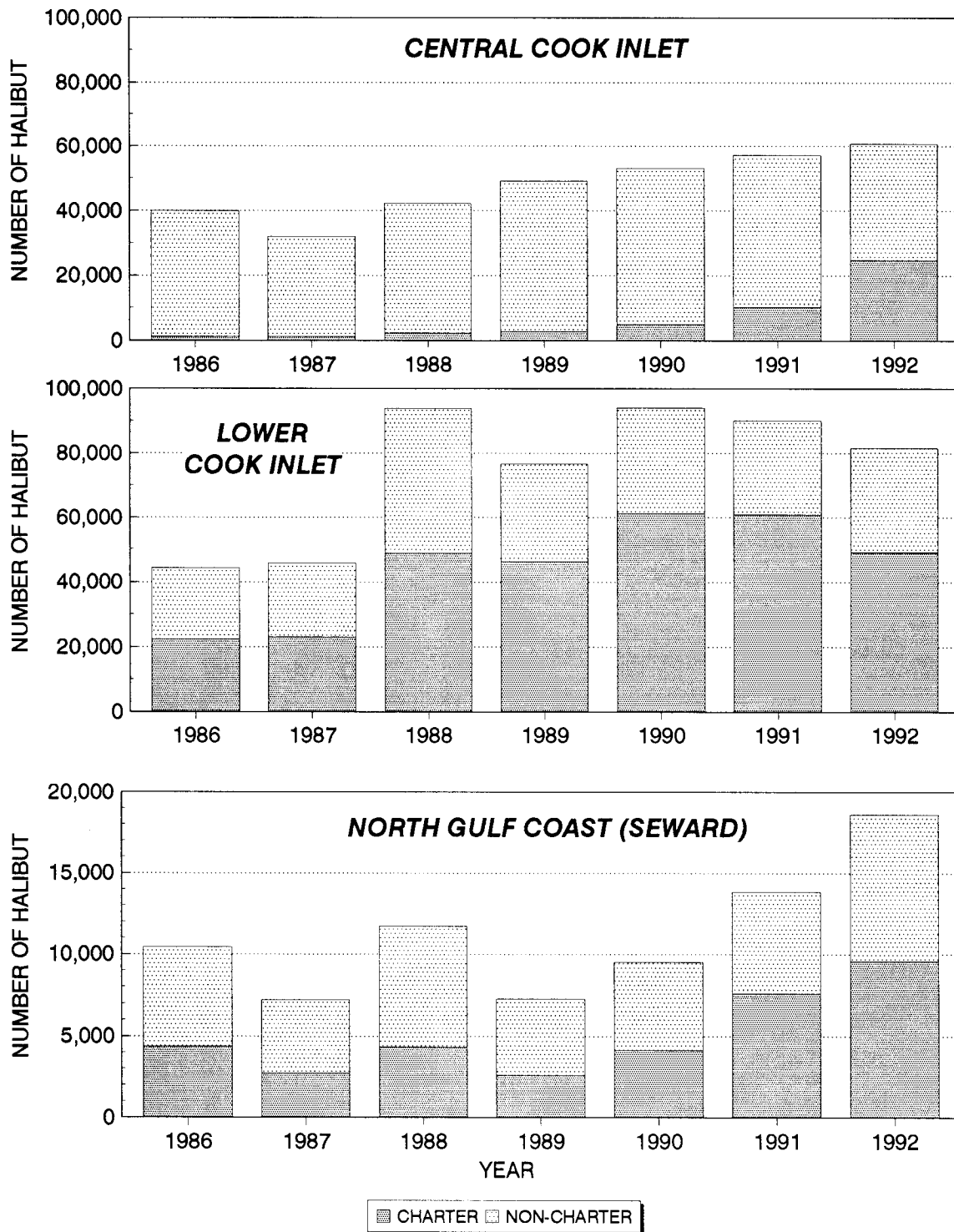


Figure 4. Recreational halibut harvest by chartered and nonchartered anglers in Kenai Peninsula fisheries, 1986-1992 (Mills 1987-1993).

The recent decrease in harvest in LCI is probably more attributable to a redistribution of fishing effort than a decrease in halibut abundance. The Deep Creek and Anchor Point fisheries are capturing the business of anglers that formerly fished at Homer. In addition, Kenai River guides are reportedly moving to Deep Creek to circumvent restrictions on the Kenai River chinook salmon *Oncorhynchus tshawytscha* fishery. The CCI saltwater fishery offers opportunities to harvest halibut as well as chinook salmon, is a shorter drive from Anchorage than Homer, and is a shorter and often smoother boat ride to the fishing grounds. Use of tractors to launch boats has reduced congestion at boat ramps and allowed launching of larger boats on any tide.

Kodiak

Halibut are harvested from numerous locations surrounding Kodiak and Afognak Islands, but the vast majority of harvest is taken in Chiniak Bay and other waters close to the port of Kodiak. Most boats based in Kodiak fish north of Cape Chiniak and only occasionally venture farther west than Whale Island and as far north as the north side of Marmot Bay (Figure 5). The most heavily fished waters are in the vicinity of Buoy 4, Spruce Cape, Woody Island, and Long Island, all less than 20 km from port (Meyer 1993b).

Although Kodiak is the hub of a thriving commercial longline fishery for halibut, the sport fishery is of much lower magnitude. Harvest in the Kodiak area, including waters surrounding Kodiak, Afognak, and the Barren Islands, grew from about 1,000 fish in 1977 to 12,100 fish in 1991, then decreased slightly in 1992 to 10,900 fish. The 1992 Kodiak harvest made up only 6% (in number) and 8% (by weight) of the Area 3A total harvest (Appendix A3). Approximately 30 boats are fully licensed to participate in the halibut charter fishery, but only about 12-15 are consistently active in the fishery. In addition, an estimated 18-20 lodges provide bottomfish services in Kodiak area waters. Most effort and harvest in the Kodiak area, however, is by unguided anglers. A noteworthy portion of the unguided effort for halibut is by anglers utilizing a small fleet of 17-foot boats leased by the U.S. Coast Guard. Growth of the Kodiak fishery will probably continue to be constrained by geographic isolation and the high cost of transportation from the mainland.

North Gulf Coast

Although Seward is practically the only access point for this fishery, effort is spread over an extremely large geographic area. Boats occasionally fish as far west as Nuka Bay and as far east as Cape Cleare, a maximum distance of 110 km from Seward (Figure 6). Most of the halibut effort and harvest, however, is distributed outside of Resurrection Bay between the Chiswell Islands and Cape Puget (Meyer 1992, 1993b). A net redistribution of effort outward from Seward has occurred in the last 20 years (Meyer 1992).

Harvest in the North Gulf Coast fishery rose from 1,700 fish in 1977 to 18,600 fish in 1992 (Appendix A2). Most of the growth has occurred since 1985. Harvest reached a low in 1989, presumably because of diversion of anglers and vessels to the Exxon Valdez oil spill cleanup in Prince William Sound. Harvest, particularly by chartered anglers, has increased steadily since 1989 (Figure 4). Seward currently supports a bottomfish charter fleet of 40-50 boats, including 15 boats at the Seward Military Recreation Camp, and about one-half of the halibut harvest has been taken by chartered anglers in recent

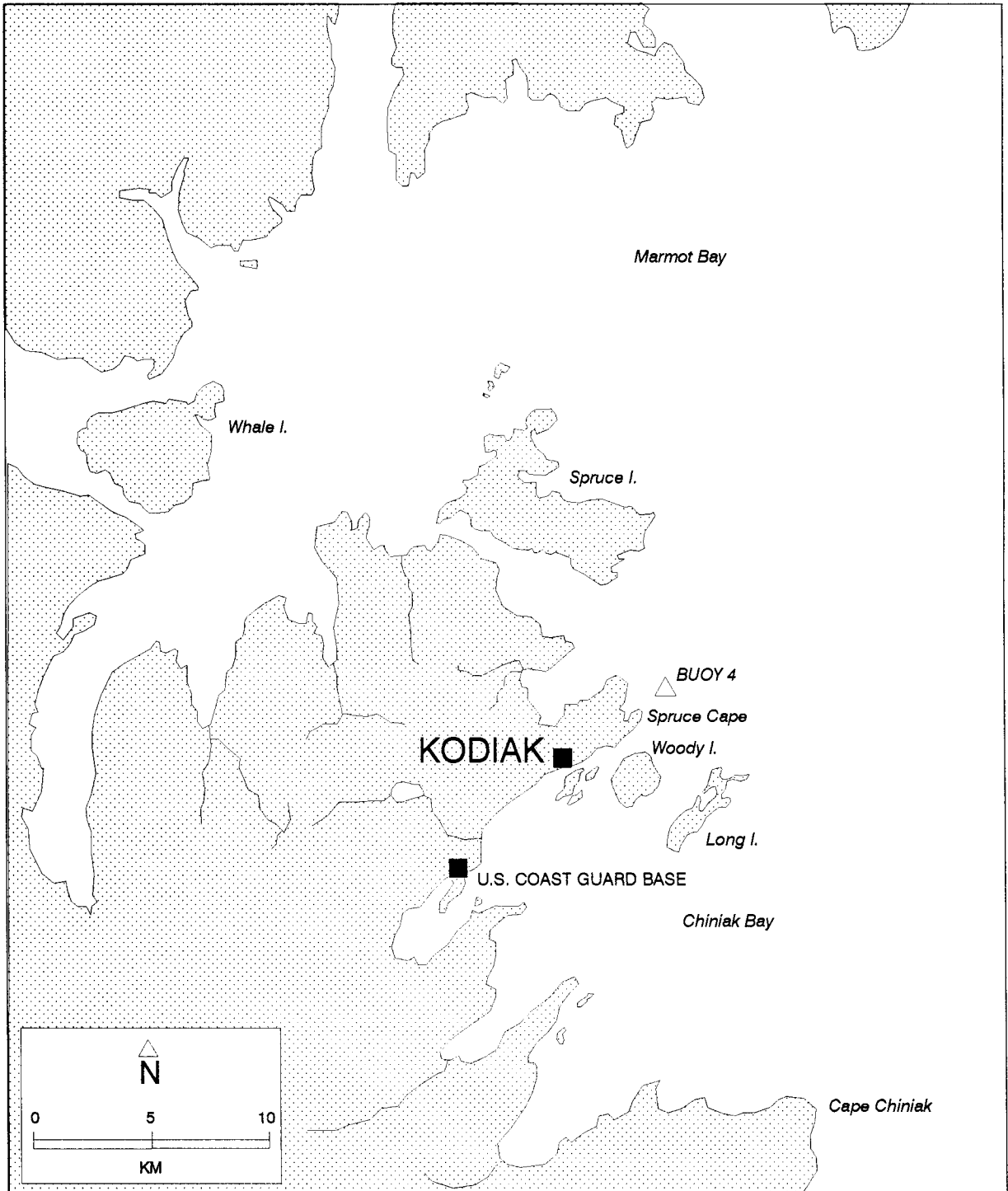


Figure 5. Waters fished by the Kodiak-based recreational halibut fleet.

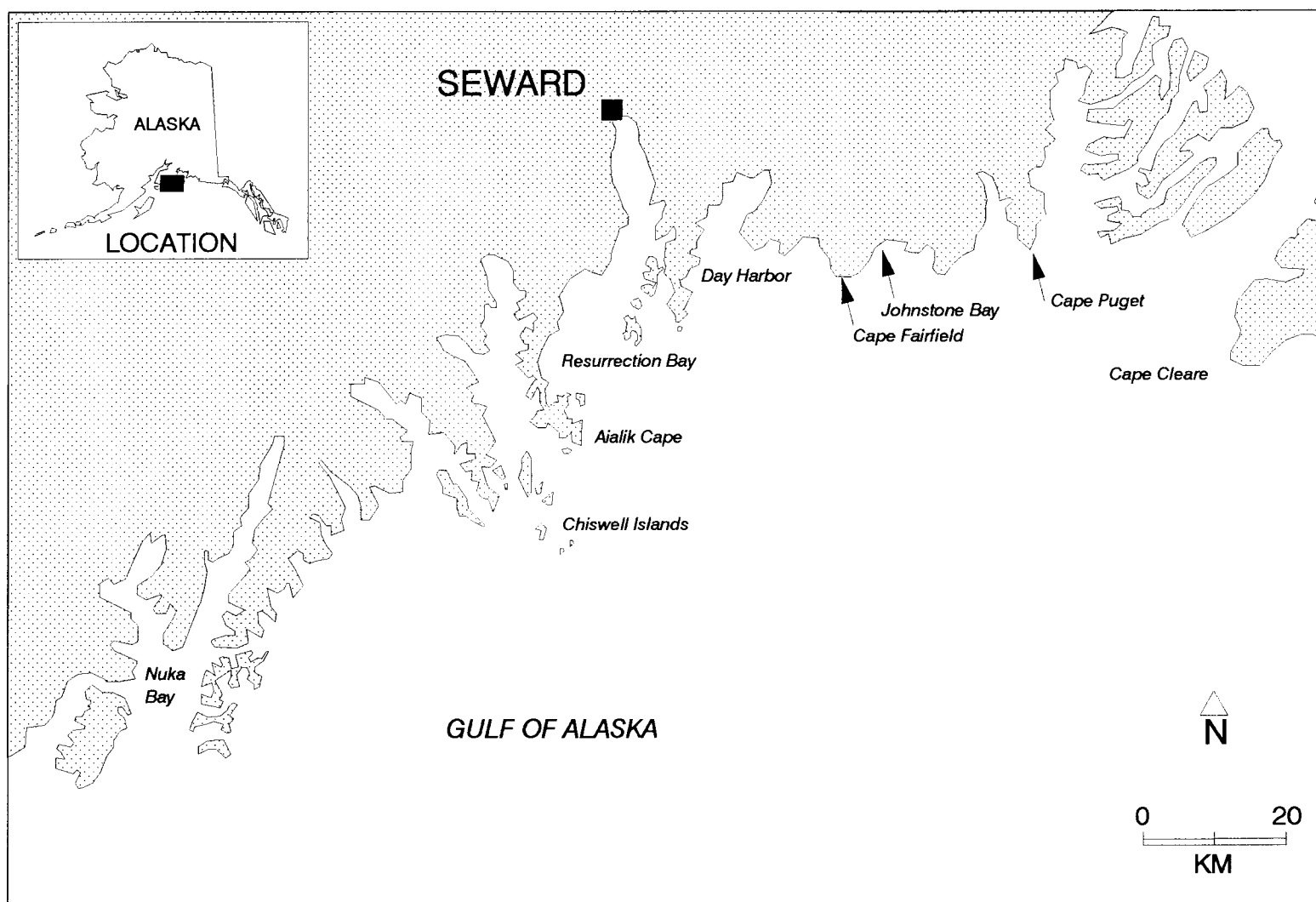


Figure 6. North Gulf Coast waters fished by the Seward-based recreational halibut fleet.

years. Although the Seward harbor is overcrowded and has a long waiting list for slips, some growth of the fishery is likely. Seward is only a 2-hour drive from Anchorage, and the City of Seward is currently planning construction of an additional launching ramp.

Prince William Sound

Halibut harvest in Prince William Sound grew from 1,250 fish in 1977 to 17,900 fish in 1992 (Appendix A2). The majority of the Prince William Sound recreational halibut harvest is taken from boats based in Valdez. Valdez currently supports an active civilian charter fleet of about 30 boats, with about half that number consistently active. Although Whittier is close to Anchorage and supports high recreational boating use, most boaters do not fish for halibut and the harvest is a small percentage of the total for the sound (Mills 1979-1993, Meyer 1992). There are only four charter fishing vessels. Likewise, Cordova supports a large and active commercial fleet, but there is relatively less interest in recreational halibut fishing and only two charter vessels. Planned construction of a road connecting Cordova with the Alaska highway system would probably result in some growth of the recreational fleet and increased harvest.

Valdez-based boats generally fish a north-south corridor between Valdez Arm and Hinchinbrook Entrance, on the eastern side of the sound (Meyer 1992, 1993b). Popular sites include Bligh Reef, Knowles Head, Hinchinbrook Entrance, and Seal Rocks (Figure 7). Few private boats from Valdez fish sites south of Knowles Head, but most charter boats are equipped to handle rougher water and often fish the Hinchinbrook Entrance area, 100-120 km from Valdez. Although Whittier-based boats concentrate bottomfishing effort in the northwestern corner of Prince William Sound, in Passage Canal, Blackstone Bay, and in waters near Esther and Perry Islands, they have reportedly fished the southwestern corner of Prince William Sound, 110 km from port.

DATA SOURCES

The Alaska Department of Fish and Game (ADF&G) has two major sources of information for the Area 3A halibut fishery: (1) a statewide postal survey to estimate effort and harvest, and (2) port sampling to estimate biological characteristics of harvested fish and collect ancillary fishery data.

Postal Survey

Effort and harvest have been estimated for most fishes annually since 1977 through a statewide postal survey (Mills 1979-1993). The survey is currently mailed to a large number (30,000 or more) of households containing one or more resident or nonresident license holders. The response rate in recent years has been 50%-60%. Although survey data have been shown to be biased due to nonresponse, estimates of effort and harvest are corrected for this bias (Mills 1993, pp. 3-5). The survey provides estimates of the number of halibut harvested by area. The survey has also provided estimates of catch (fish kept and released) since 1990, and separate estimates of harvest by chartered and nonchartered anglers in Kenai Peninsula fisheries (Cook Inlet and North Gulf Coast) since 1986. Although the survey estimates fishing effort for all species by area, effort targeted specifically on halibut is not separable.

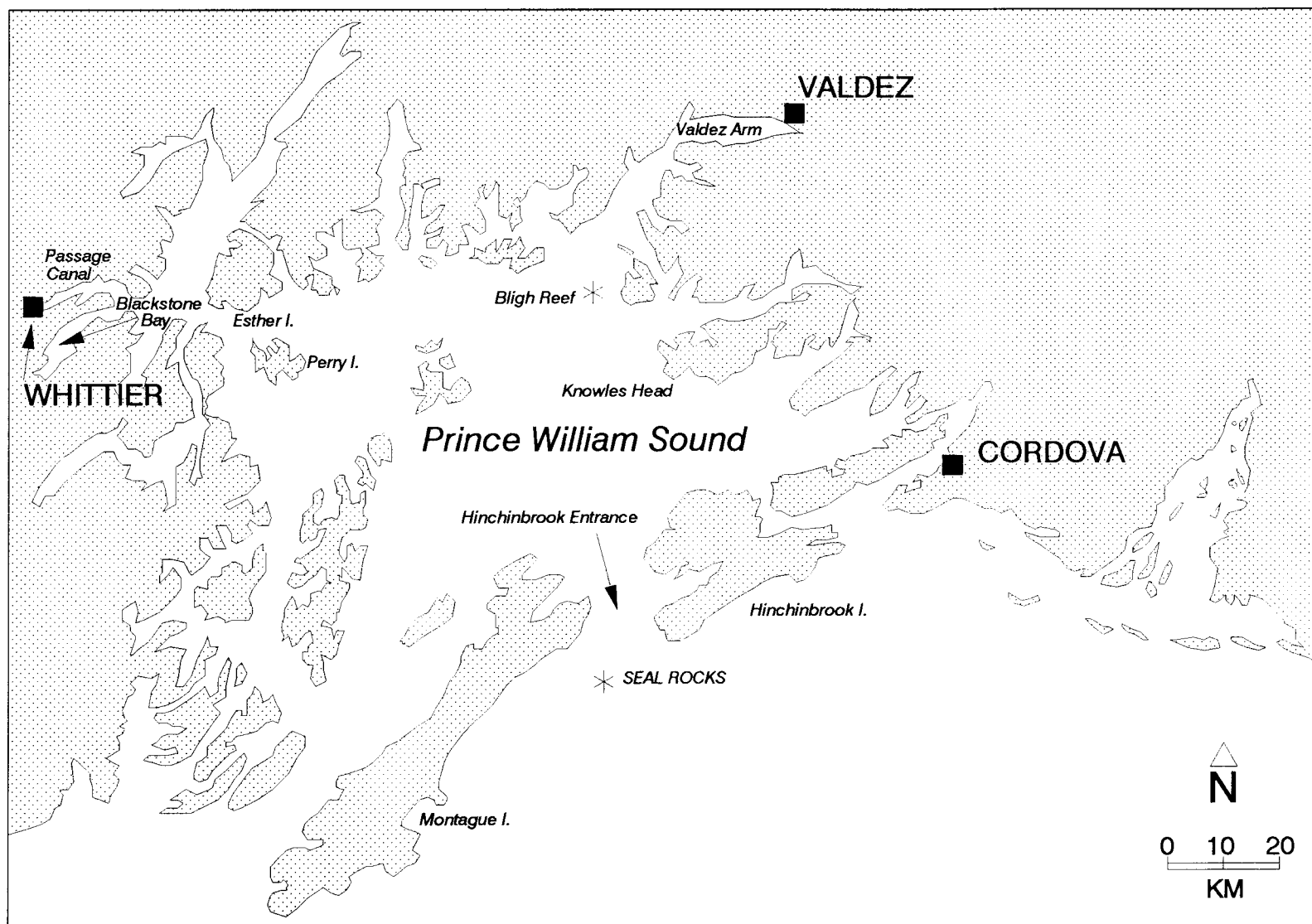


Figure 7. Prince William Sound and waters fished by recreational halibut fleets based in Whittier, Valdez, and Cordova.

The accuracy of postal survey estimates is limited by reporting errors made by survey respondents. First, site-specific estimates of halibut harvest may not be accurate in some cases. Some anglers report harvest by waters fished, while others report harvest by port of landing. Some anglers, especially guided nonresidents, often do not know where they were fishing. In past years an unlikely large percentage of the chartered harvest at Homer was reported in Halibut Cove, an area too small to support the reported effort or harvest. Although some survey respondents may have incorrectly listed the locations they fished, this error would not have affected the reported or estimated number of fish harvested. Harvest estimates presented in this report are grouped into larger areas based on the most likely port of landing to alleviate this problem. Second, some anglers are new to halibut fishing or unfamiliar with marine fish identification. Each year a very small percentage of anglers contacted by ADF&G staff confuse arrowtooth flounder *Atheresthes stomias*, starry flounder *Platichthys stellatus*, and other flatfish with halibut. The number of misidentified fish is unknown but believed to be very low, however, and the overall effect on harvest estimates would be to bias them slightly high. Third, an improbably high number of halibut (as well as other bottomfish) are reportedly taken from shore. Given the lack of roadside accessibility to halibut habitat, these fish are probably either flounders or halibut taken from boats fishing near shore, and this situation essentially represents a combination of the previous two. Reported shoreline harvest represents a very small proportion of the total harvest (0.9% in 1992) (Mills 1993). All shoreline harvest has been combined with the noncharter boat harvest for this report.

In spite of these limitations, there is strong evidence that the postal survey estimates are precise and accurate enough for management of the resource. The precision of postal survey estimates increases with the number of responses (Mills and Howe 1992). Over 10,000 survey responses were used to generate the 1992 halibut harvest estimate for Area 3A. The relative precision of the 1992 estimate for southcentral Alaska (closely equivalent to Area 3A) was 3.5% (Michael Mills, ADF&G, Anchorage, personal communication). This high level of precision generally cannot be attained even by onsite creel surveys. Postal survey estimates have also been shown repeatedly to be comparable to onsite creel survey estimates in other fisheries when the number of responses is high (Mills and Howe 1992). Favorable comparison with independent creel surveys suggests that the postal survey generally produces accurate as well as precise estimates for large fisheries.

Port Sampling

While the postal survey is used to estimate effort and harvest, the ADF&G Division of Sport Fish, Southcentral Region, samples sport harvest for estimates of biological parameters in the major ports of groundfish landings in Area 3A. Several types of data have been collected on halibut since the mid-1980s. Various combinations of age, length, and sex data were collected at Seward in 1988, 1989, and 1990 (Vincent-Lang 1991), at Deep Creek in 1988 (unpublished data), at Homer in 1988 (unpublished data) and 1989 (Roth 1990), at Kodiak and Cordova in 1989 (Roth 1990), and at Valdez in 1989 (Roth 1990) and 1990 (Meyer 1992). Some data collected prior to 1991 were obtained incidental to sampling for other species or objectives and may not provide representative estimates of biological characteristics of halibut.

The department began a long-term port sampling program in 1991 to collect basic biological data from groundfishes harvested in recreational fisheries throughout southcentral Alaska. Although the project was initiated largely out of concern for rockfishes *Sebastes* and lingcod *Ophiodon elongatus*, it afforded the opportunity to gather halibut data for use by the IPHC and other agencies. Part Two of this report provides a detailed explanation of data collection and analytical procedures used in 1993. Project objectives and methods are reviewed and approved each year by the IPHC prior to the field season, and data are summarized and forwarded to the IPHC for eventual incorporation in annual stock assessments. Age, length, and sex composition were estimated for Homer, Seward, and Valdez every year since 1991, for Deep Creek and Whittier in 1991, and for Kodiak in 1992 and 1993 (Meyer 1992, 1993a). Other types of fishery information collected included the geographic distribution of bottomfishing effort and angler characteristics (e.g. guided/unguided). In addition, the Seward Military Recreation Camp has provided a complete log of effort and harvest by their fleet of 15 charter boats since 1987.

Information provided by ADF&G is needed for management of the fishery. The IPHC uses harvest estimates in accounting for all removals and generating reliable estimates of exploitable biomass and allowable catch. Age composition of the sport harvest will be incorporated into catch-at-age analyses to estimate exploitable biomass after more years of data become available. Estimates of the mean weight of fish taken in the sport fishery are used to obtain the harvest in pounds. Information on length and sex composition can be used to evaluate the effects of traditional management measures, such as size limits. Tallies of harvest per boat trip are used to evaluate the effects of changes in bag limits. Finally, knowledge of areas fished may be useful in evaluating competition on the fishing grounds and localized stock depletion.

HARVEST AND STOCK COMPOSITION

Halibut harvested by sport anglers are generally smaller and younger than fish taken in the commercial fishery. Most of the age and size differences between sport and commercial harvests are due to the fact that the sport fishery is not constrained by the 32 inch (81 cm) minimum size limit applied to the commercial setline fishery. Fish under 32 inches made up about 30% of the Kodiak, Homer, and Valdez sport harvests, and 53% of the Seward harvest in 1992 (Meyer 1993a). Most of the recreational harvest is 60-130 cm long, while commercial setline harvest is all over 81 cm. About 90% of the recreational harvest in recent years was 5-12 years old, with the modal age at 8-10 years (Meyer 1992, 1993a). By comparison, roughly 90% of the commercial harvest in recent years was 9-16 years old, with modal ages of 10-12 (Sullivan 1993).

There are significant geographic differences in size, age, and sex composition of the sport harvest even within Area 3A. One of the largest differences is that males make up roughly 40% of the Seward harvest, compared with 15%-20% at other ports. As a result, fish landed at Seward are considerably smaller than fish taken at other ports (Meyer 1992, 1993a). Differences among ports in age composition are not as dramatic or apparent. There was some evidence in 1992 that the mean length-at-age was lower for males and females landed at Seward, and this question was investigated using 1993 data (see Part Two). Reasons

for regional differences are not understood, but some of these differences must be accounted for when estimating the recreational harvest biomass for Area 3A.

Changes in size and age composition of the recreational harvest appear to reflect changes in the stock to a limited extent. For example, even though the sport fishery is selective for certain ages and sizes, relatively strong and weak year classes correlate and track over time. Because halibut recruit to the sport fishery at a younger age, sport harvest age data provide clues to upcoming year class strength.

The relationship between harvest and stock composition is influenced by seasonal changes in fish availability, changes in the fishery patterns, and improvements in technology. Each year the size composition of halibut harvested from Cook Inlet varies within the season, with more large fish taken in July and fewer large fish taken toward the beginning and end of the season (Meyer 1992, 1993a). This pattern is consistent with tagging data that suggest summertime onshore migrations of adult halibut (IPHC 1987). Halibut harvested in May 1992 at Seward were unusually large relative to other months (Meyer 1993a). This was because most of the fish taken in May were caught by anglers on civilian charter boats, and fish taken by this group were significantly larger than fish taken by other types of anglers. In general, there are often significant differences in the sizes and catch rates of various user groups that may be a function of fishing expertise, onboard equipment, and boat size. The catch rate of chartered anglers, for example, was five times that of unguided anglers at Valdez in 1988 (Roth and Delaney 1989). If effort, fishing methods, and waters fished are relatively constant over time, then observed trends in harvest composition probably represent real changes in the halibut stock itself. It is therefore important to continue to monitor the percentage of harvest by each user group, size composition by user group, and the geographic distribution of effort and harvest at each port.

MANAGEMENT AND ALLOCATION ISSUES

The State of Alaska does not have management authority over halibut fisheries in state or federal waters. Instead, the halibut resource is managed for optimal sustained yield by the IPHC under the Halibut Convention of 1953 and its 1979 Protocol. The IPHC annually estimates halibut abundance using catch-at-age data and establishes the total allowable harvest under a constant exploitation rate strategy. Estimated biomass of the exploitable stock in Area 3A peaked in 1988 at 172 million pounds and is expected to decline at a rate of 5%-10% per year for several more years (Figure 8; Sullivan 1993). Recruitment and stock biomass are believed to be cyclical; if this holds true then recruitment is expected to remain low for several years.

Continued growth of the sport fishery in Area 3A necessitates the inclusion of accurate sport harvest data in annual stock assessments by the IPHC. Historically, only commercial removals were used to estimate exploitable biomass because other removals such as sport harvest were considered negligible. The IPHC has recently attempted to account for all sources of removal including sport, subsistence, bycatch, and wastage. Incorporation of sport harvest in the 1991 stock assessment led to a 10%-15% increase in overall harvest and a 10% increase in estimated biomass over recent years (Sullivan et al. 1992).

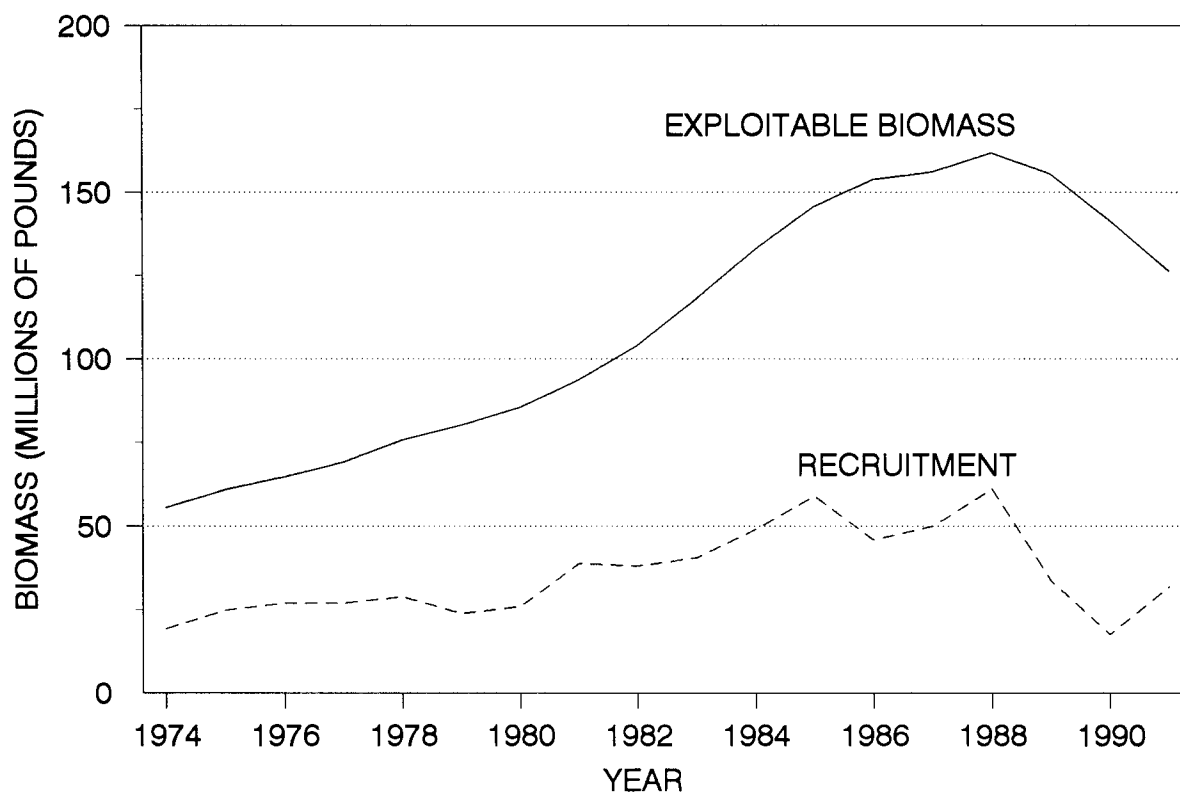


Figure 8. Exploitable stock biomass and recruitment in IPHC Regulatory Area 3A, 1974-1991 (Sullivan 1993).

Allocation of the allowable halibut harvest among user groups in U.S. waters is the responsibility of the North Pacific Fisheries Management Council (NPFMC), under the Magnuson Fisheries Conservation and Management Act of 1976. The sport fishery in Alaska has not been managed under a harvest quota and has in effect been allocated all the fish it can harvest. The recreational fishery accounted for 3.9 million pounds (Appendix A3) or 10% (by weight) of the total halibut removals in Area 3A in 1992. Other removals (in millions of pounds) included: 26.8 commercial harvest (72%), 5.0 bycatch mortality in other fisheries (13%), 1.0 waste (3%), and 0.5 personal use (2%). Waste is defined as mortality of sublegal size halibut and fish killed by lost or abandoned setline gear. Directed commercial harvest, bycatch in other commercial fisheries, and waste accounted for 88% of all removals.

The Alaska Longline Fishermen's Association (ALFA) submitted a proposal to the NPFMC in May 1993 to establish a harvest quota for the sport charter industry in Alaska. The proposal was intended to address what ALFA perceived to be "rapid, uncontrolled growth of the guided sport halibut charter industry" in Alaska. ALFA believes that continued growth of the sport fishery, particularly the guided component, is inevitable. Given that the halibut resource is fully utilized, ALFA believes that without restriction this growth will cause reallocation of halibut away from the directed longline fishery. This reallocation would result in economic and social costs to the traditional longline fishery. The objective of their proposal is to minimize such impacts. The NPFMC is currently studying this issue and will likely not take any final actions before 1995.

There is precedence for establishing a halibut allocation to the sport fishery. The sport fishery in IPHC Regulatory Area 2A (coastal waters of Washington, Oregon, and California) has been allocated an annual harvest quota consisting of a fixed percentage of the total allowable harvest. Unlike the ALFA proposal, the Area 2A harvest quota applies to the overall sport fishery, both guided and unguided.

Responsible decisions regarding allocation of the resource should incorporate the best available information on the status and effects of the sport fishery. Even though the Alaska Department of Fish and Game lacks management authority for halibut, it is committed to obtaining and providing the IPHC and NPFMC with the information needed for wise management and fair allocation.

PART TWO - 1993 FISHERY STATISTICS

GOALS AND OBJECTIVES

The goal of halibut research by the ADF&G Division of Sport Fish is to provide timely and accurate biological data to be used for management of the resource for optimum sustained yield. Most importantly, estimates of age and size composition are needed by the IPHC for annual stock assessment. Other information is needed to better understand halibut stock dynamics and manage the sport fishery. Therefore, objectives of 1993 research efforts were to:

1. Estimate the age, length, and sex composition of halibut harvested at Kodiak, Homer, Seward, and Valdez during May through September,
2. Estimate the proportion of halibut effort and harvest in each geographic area, user group, species targeted, and gear type at Kodiak, Homer, Seward, and Valdez,
3. Evaluate the likely effects of a bag limit reduction on recreational halibut harvest, and
4. Test for differences between ports in mean length-at-age of male and female halibut.

METHODS

Study Design

Technicians were stationed at Kodiak, Homer, Seward, and Valdez. These ports were chosen to provide representative data on recreational halibut harvest from Prince William Sound, Lower Cook Inlet, Kachemak Bay, and the nearshore waters of the Gulf of Alaska between Hinchinbrook Island and Cape Chiniak on Kodiak Island (Figure 1). The ports of Kodiak, Homer, Seward, and Valdez probably accounted for a majority of the Area 3A harvest. In support of this, the number of halibut landed at these ports in 1992 made up about 64% of the Area 3A harvest (Mills 1993).

Sampling was conducted 5 days per week, including all weekends and holidays, at each port. Days off were Tuesday and Wednesday with a few exceptions. Data collection consisted of two components: (1) collection of biological data from harvested halibut, and (2) interviews with anglers and charter boat crews for ancillary fishery data. At all ports but Kodiak, biological sampling was conducted 3 days per week, and interviews were conducted 2 days per week. Fish and interview sampling days were chosen at random from the period Thursday-Monday. At Kodiak, fish were sampled concurrently with angler interviews 5 days per week. Technicians sometimes also sampled fish on dedicated interview days but only when harvest was low and the sampling rate could be achieved without missing fish or interviews.

Biological Sampling:

The hours sampled varied by port and by day in response to weather and other variables, but generally included the period 1500-2200 hours when most anglers return to port. Sampling at Valdez was often conducted during the period 1600-2400 hours because many of the boats return later. Technicians intercepted cleaned fish carcasses at fish cleaning stations in the boat harbors and at charter operator offices. Designated barrels were placed near the cleaning stations or boat ramps to collect fish carcasses when the technician was busy or off-duty. Signs were posted in each harbor explaining the sampling program and requesting angler cooperation.

The sampling routine varied by port to suit local conditions. Kodiak was sampled at St. Paul's Harbor, St. Herman's Harbor, at the Unification Church dock, and at the U.S. Coast Guard Base boat ramp. The technician "cycled" through the four sites, starting at a different site each day. The technician would interview anglers, sample available fish, then move to the next site. If not all fish could be sampled, the technician would request anglers to leave carcasses in the collection barrels and then sample the fish on the next visit to that site. Each site was sampled 2-3 times per day on average. Some boats, particularly charter boats, would clean fish on the way in and only save a portion of the carcasses. None of these would be sampled unless the skipper had made a prior arrangement with the sampler to retain all carcasses or a systematic (and therefore representative) sample of carcasses.

The Homer fishery was sampled only at the harbor on the Homer Spit. The technician sampled fish at the public cleaning station and boat ramp while monitoring the return of charter boats. Charter boats tended to return in large groups represented by one or more charter companies. As these boats returned, the technician would interview the skippers or deck hands to determine the areas fished, sample the fish, then return to the public cleaning station. This alternation of sampling sites allowed the technician to monitor incoming harvest and expend sampling effort proportionately among the various sites. Interviews with anglers and skippers, as well as observation of offloading, revealed that some fish were cleaned at sea. These were most often small fish, but sometimes included larger fish when only one or two were harvested by a boat party. The known number of fish missed each day was not recorded at Homer, but was felt to be either relatively constant throughout the summer or too low to cause significant bias in estimation.

Seward was sampled at the boat harbor and at both fish cleaning stations in the Seward Military Recreation Camp. The technician would begin by sampling at the boat harbor while monitoring the return of military charter boats. Once most of the military boats were in, fish would be sampled at the Military Recreation Camp cleaning stations for 1-2 hours. The technician would then return to the harbor to finish the shift. Most anglers deposited cleaned fish carcasses in collection barrels while the technician was away. Although a portion of the harvest was undoubtedly missed by this sampling scheme, there was no reason to assume that missed fish were characteristically different than sampled fish.

The Valdez technician simply cycled through the cleaning stations and boat ramps in the harbor. Each site was visited numerous times during a shift, and few anglers or fish were missed.

Systematic sampling with a variable sampling rate was employed at all ports to insure that biological samples were representative of the harvest. Because the harvest of halibut and other fishes varied daily and seasonally, the sampling rate was adjusted periodically to allow technicians to draw each day's sample from the entire pool of fish available during a work shift. The choice of sampling rate also took into account progress toward the minimum required sample size each month and the number of other species available for sampling. Homer and Seward required more frequent adjustment of sampling rates because of unexpected variation in bottomfish harvest. The sampling rate was applied to all sublocations from which fish were obtained at each port so that private, charter, and military components were sampled proportionately.

All halibut were measured to the nearest millimeter in a straight-line distance from the tip of the snout to the tip of the center lobe of the tail. Sex was determined by visual inspection of gonads. Otoliths (sagittae) were removed and stored in paper coin envelopes. Whenever possible, the user group (e.g. charter, noncharter) and ADF&G statistical area of capture were recorded for each fish.

Otoliths were cleared by soaking in a 50:50 mixture of glycerin and water for at least 2 weeks. Whole left otoliths were aged under a dissecting microscope (Chilton and Beamish 1982). In order to minimize between-year drift in aging, the reader re-aged subsets of otoliths collected in previous years. The reader did not begin reading otoliths collected in 1993 until a high percentage of assigned ages agreed with past ages assigned, and "errors" were distributed symmetrically. The ADF&G and IPHC have shared age structures in past years and always had good agreement in assigned ages (Meyer 1992, 1993a). Although no subsamples of otoliths were read by both agencies this year, the ADF&G reader worked directly with the IPHC aging lab supervisor to resolve questions on difficult-to-read otoliths.

All biological data collected in 1993 are archived with ADF&G, Division of Sport Fish, Research and Technical Services (RTS) in Anchorage. Data are stored in Mark-Sense Biological (AWL) file format, and are available upon request (see Appendix B for filenames).

Angler Interviews:

Anglers were interviewed to gather information on composition of the effort and harvest by area, user group, targeted species, and gear type. Locations were coded to statistical areas used by the National Marine Fisheries Service and ADF&G for recording groundfish harvest. Statistical areas are delineated roughly by latitude and longitude. Only boats targeting bottomfish (halibut, lingcod, or rockfish) were included in interview samples, and interviews were obtained regardless of fishing success. At least one person from each boat was interviewed to gather data on the completed boat-trip. Generally only captains or crew were interviewed off charter boats because many clients did not know where they were fishing and did not keep track of total harvest for the boat. Information gathered for each boat-trip included: (1) user group (e.g. private, military, charter); (2) statistical area fished; (3) number of anglers on the boat; (4) species targeted (e.g. halibut, halibut + rockfish, etc.); and (5) number of halibut, rockfish, and lingcod kept. As with fish

sampling, systematic sampling was used to gather interviews, and sampling designs varied by port depending on harbor layout and level of effort.

The Homer boat harbor was too large and effort was too great to contact all returning boats. Therefore, the Homer harbor was broken into five approximately equal areas. Interviews were conducted for 1 hour in each area during the period 1500-2000 hours. Approximately 90% of boats return to port during this period (R. David, Homer Harbormaster, personal communication). The roll of a die determined the sequence with which areas were sampled each day, and systematic sampling rates were applied to all returning boats.

Interview sampling designs at Valdez and Seward were more straightforward. The Seward harbor was small enough that all nonmilitary boats returning to the harbor during the 6-hour period 1600-2200 hours were contacted for interviews. Military boats at Seward were not interviewed because they provided logbook data comparable to that collected through interviews. At Valdez, all boats returning to the harbor during the period 1600-2300 were interviewed.

All interview data collected in 1993 are archived with ADF&G, Division of Sport Fish, Research and Technical Services (RTS) in Anchorage. Data are stored in Lotus 1-2-3 binary files (WK1 format), and are available upon request (see Appendix B for filenames).

Parameter Estimation

Age, Length, and Sex Composition:

Sampling was designed to estimate age, length, and sex composition to within 0.10 of the true proportion at least 95% of the time in June, July, and August, and to within 0.15 of the true proportion at least 95% of the time in May and September. Corresponding minimum target sample sizes were 128 and 57 (Thompson 1987). Because aging is expensive and many more otoliths were collected than necessary, subsamples of approximately 150 otoliths from the central dates of each month were aged.

The proportional contribution of each age, length, or sex class to the sport harvest each month (p_{ij}) was estimated as (Cochran 1977):

$$\hat{p}_{ij} = n_{ij} / n_j \quad (1)$$

where:

n_{ij} = the number of fish of age, length, or sex i sampled in month j ,
and

n_j = the sample size in month j .

The unbiased estimator of the variance of each proportion was

$$\text{Var}(\hat{p}_{ij}) = \hat{p}_{ij} (1 - \hat{p}_{ij}) / (n_j - 1). \quad (2)$$

The finite population correction (FPC) to the estimated variance (Cochran 1977) was ignored because sample size was considered small relative to the harvest and the number of fish harvested was unknown. Estimates of variance were therefore conservative (slightly larger than if harvest were known).

Differences in age and sex composition among months, sites, and user groups were tested using chi-square contingency tables (Conover 1980). Age classes near the tails of the age distributions were pooled so that chi-square statistics were made up mostly of differences in the primary age classes. Differences in length composition among months, sites, and user groups were tested using k-sample Anderson-Darling tests (Scholz and Stephens 1987) employing the test statistic T_{akn} to determine probabilities. Monthly data were pooled to obtain age, length, and sex composition for the entire season at each site using equations 1 and 2.

Because systematic sampling rates were adjusted inseason for changing harvest levels, each period of time corresponding to a sampling rate represented a sampling stratum. When differences in age, length, or sex composition among strata were statistically significant ($P < 0.05$), the estimates for each stratum were weighted to compute composition for the entire season (Cochran 1977, page 91). Stratum estimates were weighted by the estimated fraction of the total harvest that occurred in each stratum. A rough estimate of the number of fish harvested in each stratum (N_i) was obtained by expanding monthly sample sizes by the sampling rate, accounting for fish known to have been missed by the sampler, and then expanding again for days not sampled:

$$\hat{N}_i = (n_i/f_i + m_i) / (d_i/D_i) \quad (3)$$

where:

\hat{N}_i = the estimated number of fish harvested in stratum i,

n_i = the sample size in stratum i,

f_i = the systematic sampling rate in stratum i (e.g. 1 in 4 = 0.25),

m_i = the number of fish known to be missed by the sampler because they were cleaned at sea or taken home whole,

d_i = the number of days sampled in stratum i, and

D_i = the number of days in stratum i.

The variance of each \hat{N}_i was estimated as:

$$\text{Var}(\hat{N}_i) = \frac{\sum_{i=1}^d (N_{id} - \bar{N}_i)^2 / (d_i - 1)}{d_i} (1 - d_i/D_i) (D_i/d_i)^2 \quad (4)$$

where:

N_{id} = the number of fish harvested on day d within stratum i, and

\bar{N}_i = the average number of fish harvested per day within stratum i.

Estimates of the weighting factors for each stratum (w_i) then were:

$$\hat{w}_i = \hat{N}_i / \sum_{i=1}^s \hat{N}_i, \quad (5)$$

where s = the number of strata. The estimated variance of each weighting factor was:

$$\begin{aligned} \text{Var}(\hat{w}_i) = & \hat{N}_i^2 \left(1 / \left(\sum_{i=1}^s \hat{N}_i \right)^4 \right) V \left(\sum_{i=1}^s \hat{N}_i \right) + \left(1 / \sum_{i=1}^s \hat{N}_i \right)^2 V(\hat{N}_i) - \\ & V(\hat{N}_i) \left(1 / \left(\sum_{i=1}^s \hat{N}_i \right)^4 \right) V \left(\sum_{i=1}^s \hat{N}_i \right). \end{aligned} \quad (6)$$

Weighting of estimates did not always cause significant change in distributions calculated with pooled data. In some cases this was because sample size was proportional to harvest and estimates from pooled data were self-weighting. In other cases, statistically significant differences were not functionally different. Weighted estimates were presented only when the absolute difference between weighted and unweighted estimates exceeded 10%. This was the case only for the length composition estimates at Homer. For the Homer estimates, the variances of the weighting factors were so small as to be negligible (all less than 1.3×10^{-4}).

Area, User Group, Target Species, and Gear Type Composition:

The proportions of fishing effort (angler-days) and halibut harvest (number of fish) in each statistical area and by each user group were estimated using the procedures outlined for age composition (equations 1-2). Anglers occasionally fished multiple stat areas during a day. When calculating effort by stat area, an angler-day was tallied for each stat area in which the angler spent any portion of the day fishing. Because anglers did not keep track of harvest by stat area, estimates of the proportion of fish taken in each area were based only on boat-trips that fished a single area in any given day. This limitation may have resulted in minor underestimation of the percentage of harvest coming from the most frequently fished stat areas.

Target species data from interviews were lumped into three categories: (1) halibut exclusively, (2) halibut plus other bottomfish, or (3) other bottomfish. Similarly, terminal gear types were categorized as either (1) bait only; (2) bait in addition to other gear (e.g. bait on a jig, or bait part of the day, jig part of the day); and (3) other gear types. The proportions of effort and harvest were estimated for the major target species and gear type categories using equations 1 and 2. All estimates were computed separately

for the civilian and military fisheries at Seward because military data forms requested more general target and gear type information.

Effects of a Bag Limit Reduction:

The current daily bag limit of two halibut per person is a primary regulation controlling harvest in the Area 3A recreational fishery. Given that further restriction of the sport harvest has been proposed, it was natural to estimate the effect of a daily bag limit reduction on total harvest. Completed-trip interviews provided the number of fish landed per boat-trip, but data for individual anglers were not available. Although illegal, anglers often share their catch so that as many anglers as possible attain their limit of two fish. The harvest was therefore classified into two groups: fish representing either (1) the first fish in the bag limit, or (2) the second fish in the bag limit. For example, if a boat with six anglers returned to port with ten fish, six of the fish represented "first fish" (one for each angler), and the remaining four represented "second fish." Reduction of the daily bag limit to one fish per day could be expected to reduce harvest by the proportion of the total harvest composed of "second fish."

Mean Length and Weight:

Mean length was computed as the arithmetic mean of all fish measured at each port. Because most measurements were from cleaned carcasses, most fish could not be weighed. Weights were therefore estimated using the recently validated length-weight relationship for halibut (Clark 1992):

$$\hat{W} = aL^b \quad (7)$$

where:

\hat{W} = the predicted weight in pounds,

L = the observed length in centimeters,

$a = 6.921 \times 10^{-6}$ for net weight (eviscerated, head off), and 9.205×10^{-6} for round weight, and

$b = 3.24$.

Mean weights (net and round) were computed as the arithmetic means of predicted weights of all sampled fish (Nielsen and Schoch 1980). Variances of mean weights based on pooled data were estimated using standard normal procedures (Cochran 1977, page 26) substituting predicted for observed weights. Variance estimates for mean weights were considered minimum estimates because they did not incorporate variance in the length-weight relationship. Weight data were presented in pounds because that is the standard unit used by the IPHC.

Because differences in length composition over time were statistically significant at Homer, estimates of mean length and mean weight for this port were stratified by the estimated w_i . For example, stratified mean weight was estimated as:

$$\bar{W} = \sum_{i=1}^s (w_i \bar{W}_i) , \quad (8)$$

where \bar{W}_i = the mean weight in stratum i . Three strata were chosen post-season, based on trends in the daily mean length and variance, to minimize the variance within each stratum. Variances of the weighting factors (equation 6) proved to be negligible. Therefore, variances of the stratified estimates of mean weight were simply:

$$\text{var}(\bar{W}) = \sum_{i=1}^s [w_i^2 V(\bar{W}_i)] . \quad (9)$$

Tests for Mean Length-at-Age:

Plots of mean length-at-age indicated that male and female halibut harvested at Seward were consistently smaller than halibut at other ports in 1992 (Meyer 1993a). Differences in mean length-at-age of fish harvested in 1993 were tested among ports using a two-factor analysis of variance (ANOVA). Both age and port were considered fixed effects. The ANOVAs were performed separately for each sex.

RESULTS

Age, Length, and Sex Composition

Sampling in 1993 was conducted at all ports from late May through early September, and included the Memorial Day and Labor Day weekends (Table 3). Age, length, and sex data were gathered from 3,421 halibut. The largest sample sizes were obtained in July at all ports except Kodiak. Expanding sample sizes for missed fish (when known) and days not worked resulted in a *minimum* harvest estimate of 52,000 fish for the ports and period sampled. This estimate is undoubtedly biased extremely low, and is valuable only for year-to-year comparisons. July was the major month of harvest at all ports, accounting for 38%-47% of the total season harvest.

Age Composition:

Age composition was estimated from 2,835 aged otoliths. Ages ranged from 3 to 20 years, but about 90% of the harvest was 5-14 years old (Figure 9, Appendix C1). Differences in age composition among ports were significant ($\chi^2 = 173.6$, $df = 15$, $P < 0.001$), but there were important similarities as well. The modal age was either 9 or 10 years at all ports. The 1987 year class (age 6) appeared to be relatively strong at most ports, and the 1982 year class (age 11) appeared relatively weak at most ports, consistent with estimates from previous years.

There were no significant differences in age composition among months at Kodiak ($\chi^2 = 26.2$, $df = 20$, $P = 0.953$) or Valdez ($\chi^2 = 21.4$, $df = 20$, $P = 0.374$). Differences were significant, however, at Homer ($\chi^2 = 56.7$, $df = 16$, $P < 0.001$) and Seward ($\chi^2 = 158.8$, $df = 16$, $P < 0.001$). Although sample sizes

Table 3. Systematic sampling strata, sampling rates, and estimated proportions of the halibut harvest at Kodiak, Homer, Seward, and Valdez, 1993. Seward data are for the civilian fishery only, and do not include harvest at the Seward Military Recreation Camp.

Period	Sampling Rate (1 in __)	Sample Size	Number of Fish Missed	Number of Fish Observed	Days Worked	Days Possible	Minimum Harvest Estimate for Days Possible	Proportion of Harvest
KODIAK:								
May 26-31	1	193	0	193	6	6	193	0.061
Jun 01-30	1	517	0	517	20	30	776	0.245
Jul 01-31	3	332	0	996	23	31	1,342	0.424
Aug 01-31	3	178	12	546	22	31	769	0.243
Sep 01-08	1	83	0	83	8	8	83	0.026
Total		1,303	12	2,335	79	106	3,163	
HOMER:								
May 26-31	10	149	0	1,490	6	6	1,490	0.047
Jun 01-30	20	195	0	3,900	12	30	9,750	0.309
Jul 01-31	25	268	0	6,700	15	31	13,847	0.439
Aug 01-18	25	60	0	1,500	5	15	4,500	0.143
Aug 19-22	10	8	0	80	2	4	160	0.005
Aug 23-31	5	99	0	495	5	9	891	0.028
Sep 01-12	5	88	0	440	6	12	880	0.028
Total		867	0	14,605	51	107	31,518	
SEWARD:								
May 27-31	5	84	40	460	5	5	460	0.035
Jun 01-30	10	163	153	1,783	12	30	4,458	0.340
Jul 01-31	10	218	73	2,253	14	31	4,989	0.381
Aug 01-15	10	60	0	600	5	15	1,800	0.137
Aug 16-31	5	93	12	477	8	16	954	0.073
Sep 01-02	5	0	3	3	1	2	6	0.000
Sep 03-12	2	117	70	304	7	10	434	0.033
Total		525	351	5,880	52	109	13,101	
VALDEZ:								
May 27-31	2	96	0	192	5	5	192	0.048
Jun 01-30	3	171	0	513	14	30	1,099	0.274
Jul 01-31	3	268	104	908	15	31	1,877	0.468
Aug 01-18	3	55	13	178	6	18	534	0.133
Aug 19-31	2	87	0	174	9	13	251	0.063
Sep 01-08	1	49	0	49	7	8	56	0.014
Total		726	117	2,014	56	105	4,009	

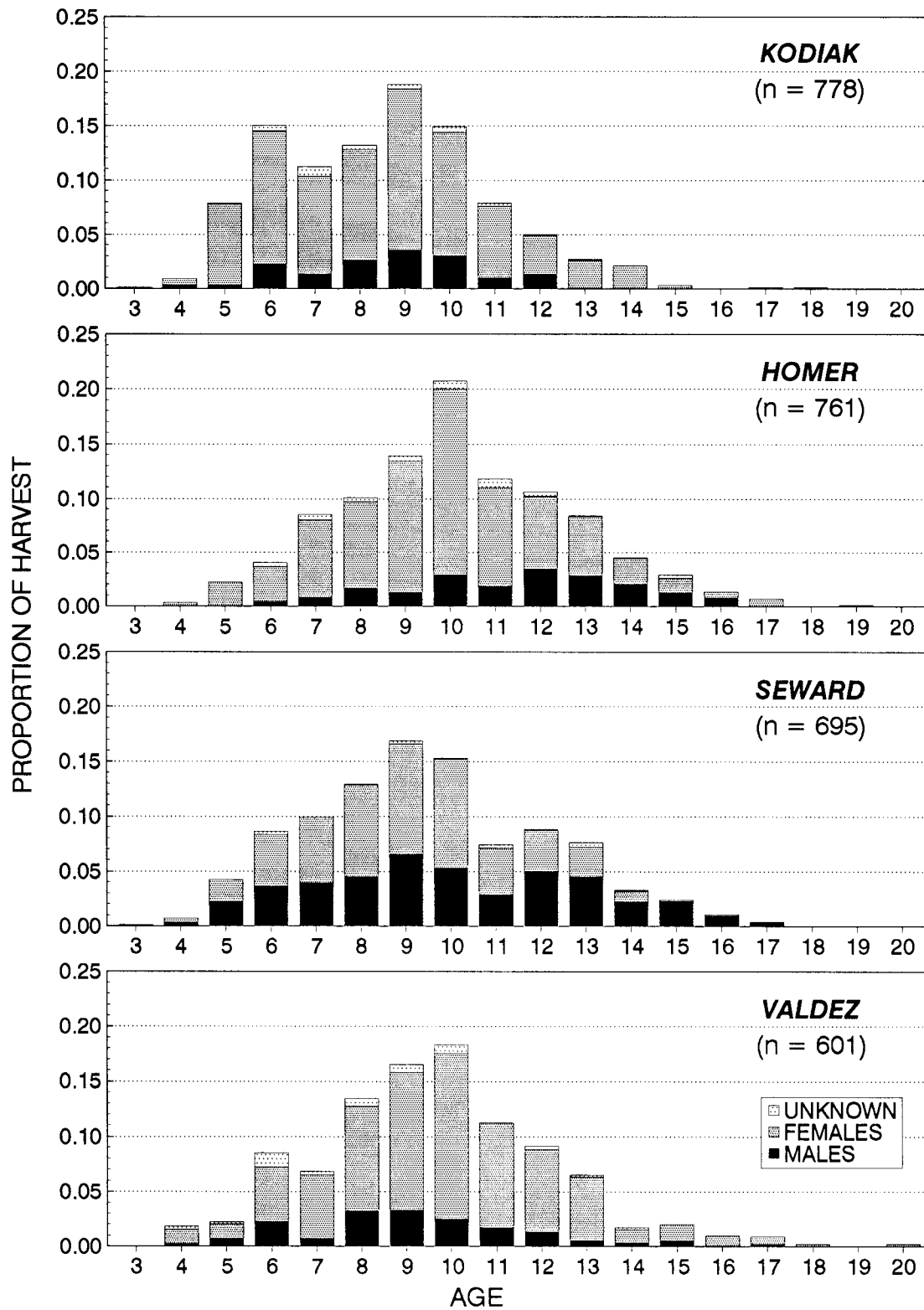


Figure 9. Estimated age composition, by sex, of the recreational halibut harvest at Kodiak, Homer, Seward, and Valdez in 1993.

were not proportional to the number of fish harvested each month, stratification of age composition estimates was unnecessary. Stratified and unstratified estimates were not significantly different at any port, and the maximum difference between stratified and unstratified estimates for any age class ranged from 0.8% to 2.3%, well within the desired level of precision.

Length and Weight:

A total of 3,577 fish was measured from all ports. Estimated mean lengths by port ranged from 84.4 cm at Seward to 100.1 cm at Homer (Table 4). Mean net weight was lowest at Seward (14.6 lb) and highest at Homer (24.9 lb). Corresponding average round weights ranged from 19.5 pounds at Seward to 33.1 pounds at Homer. The Homer estimates of mean length and weight were stratified to account for seasonal changes.

Most fish measured were between 70 and 130 cm. Fish landed at Seward had the lowest proportion of large fish in the harvest of all ports. For example, 10% of sampled fish were over 110 cm at Seward, compared with 25% at other ports (Figure 10, Appendix C2). Homer was the port with the lowest proportion of smaller fish in the harvest.

Differences in length composition among all months were significant at all ports (Table 5). At Kodiak, however, most of the difference resulted from a high proportion of large fish taken in September (Figure 10). Differences among May, June, July, and August were not significant ($P = 0.137$). Length composition changed over the season at Homer following the same pattern observed in recent years. Fish were generally smaller early and late in the season, and largest in July. Monthly differences at Seward were caused by a lack of large fish in June and lack of small fish in September. There was no pronounced trend to account for differences among months at Valdez.

Length composition varied among user groups as well, and these differences were significant at all ports (Table 5). Fish harvested by chartered anglers were larger on average than fish taken by private (unguided) anglers at Homer, Seward, and Valdez. In contrast, fish taken by unguided anglers using U.S. Coast Guard morale boats at Kodiak were slightly larger than fish taken by other private or chartered anglers (Figure 11). Chartered anglers at Homer harvested more large fish and fewer small fish than private anglers. Surprisingly, roughly equal proportions of halibut over 100 cm were taken by private and civilian-chartered (as opposed to military-chartered) anglers at Seward, but private anglers were more likely to harvest fish under 90 cm. Military-chartered anglers at Seward harvested very few halibut over 100 cm. Private anglers at Valdez appeared more likely to harvest halibut under 100 cm than chartered anglers, but conclusions are weakened by the small number of fish that could be positively identified as private-caught. Length composition of halibut taken by military and civilian charter boats at Valdez were similar.

Sex Composition:

As in past years, females dominated the recreational harvest at all ports, but to a lesser extent at Seward (Figure 12, Appendix C3). Females made up 87% of the harvest at Kodiak, 84% at Valdez, 80% at Homer, but only 55% at Seward. Excluding Seward, differences in sex ratio among the remaining ports were still significant ($\chi^2 = 16.6$, $df = 2$, $P < 0.001$).

Table 4. Length, net weight (eviscerated, head off), and round weight statistics for the 1993 recreational halibut harvest at Kodiak, Homer, Seward, and Valdez.

Measurement	Port	Sample Size	Range	Mean	SE(Mean)
Length (cm)	Kodiak	1,271	36.3 - 183.2	92.4	0.8
	Homer	865	48.1 - 205.0	100.1	0.8
	Seward	728	46.1 - 165.5	84.4	0.7
	Valdez	713	41.0 - 211.0	97.3	0.9
Net wt (lb)	Kodiak	1,271	0.8 - 148.6	21.5	0.6
	Homer	865	2.0 - 213.9	24.9	0.8
	Seward	728	1.7 - 106.9	14.6	0.5
	Valdez	713	1.2 - 234.9	24.2	0.9
Round wt (lb)	Kodiak	1,271	1.0 - 197.7	28.6	0.8
	Homer	865	2.6 - 284.5	33.1	1.0
	Seward	728	2.3 - 142.2	19.5	0.7
	Valdez	713	1.6 - 312.4	32.2	1.1

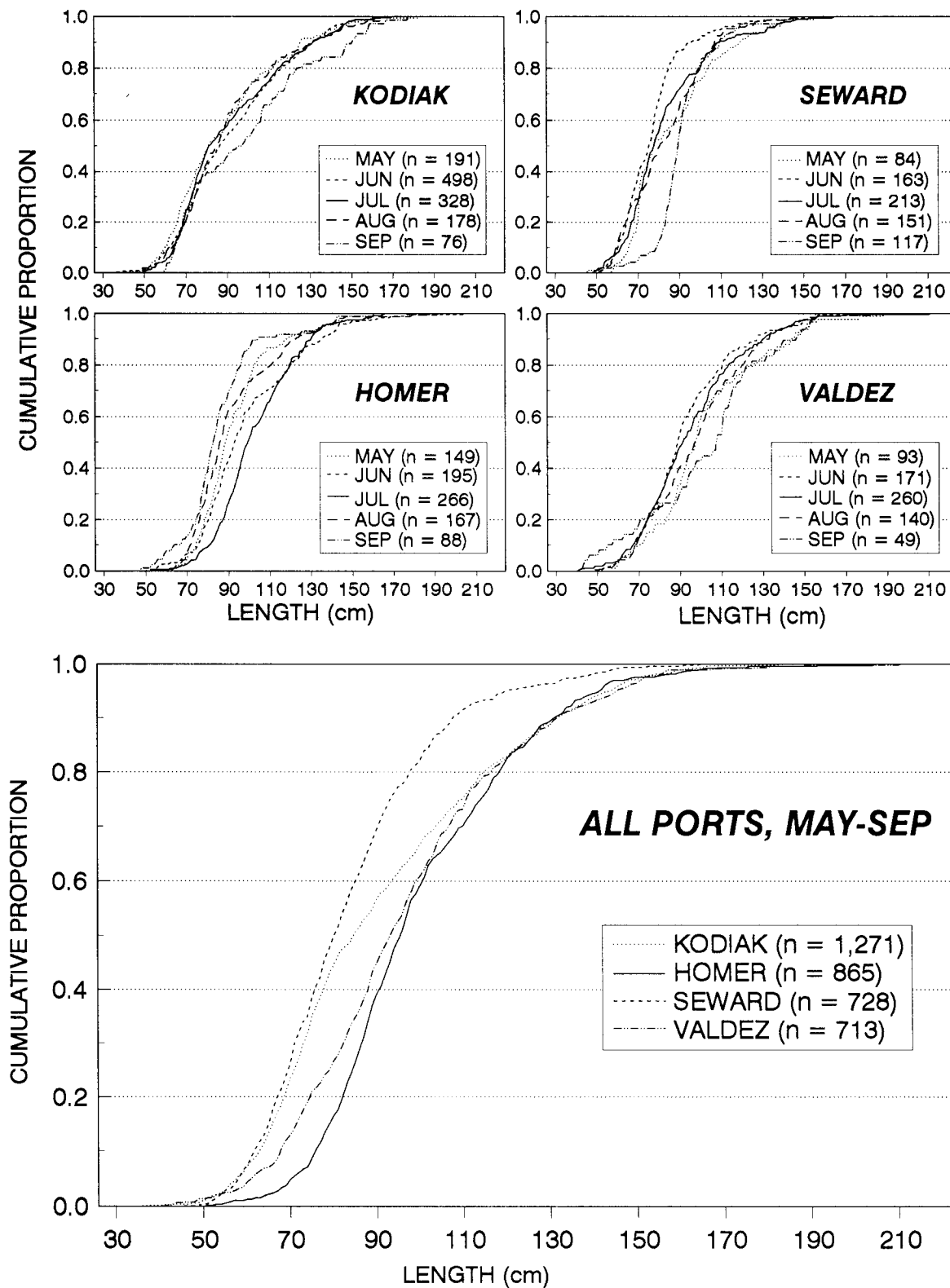


Figure 10. Estimated cumulative length-frequency distributions of the recreational halibut harvest at Kodiak, Homer, Seward, and Valdez in 1993. Upper graphs show seasonal differences at each port and lower graph shows overall length composition at all ports.

Table 5. Results of Anderson-Darling tests for differences in length composition among months and user groups, 1993.

Port	Groups Tested	T _{AD}	No. of Groups	P-value
<i>Tests Among Months:</i>				
Kodiak	May-Aug	1.1	4	0.137
	May-Sep	2.5	5	0.024
Homer	May-Sep	26.2	5	< 0.001
Seward	May-Sep	23.8	5	< 0.001
Valdez	May-Sep	4.1	5	0.003
<i>Tests Among User Groups:</i>				
Kodiak	Charter Private USCG ^a	4.5	3	0.003
Homer	Charter Private	38.3	2	< 0.001
Seward	Charter Private SMR Large ^b SMR Small ^c	73.0	4	< 0.001
Valdez	Charter Private	5.6	2	0.002

^a U.S. Coast Guard morale boats (unguided anglers).

^b Seward Military Recreation Camp chartered anglers on large boats (43-50 ft).

^c Seward Military Recreation Camp chartered anglers on small boats (27 ft).

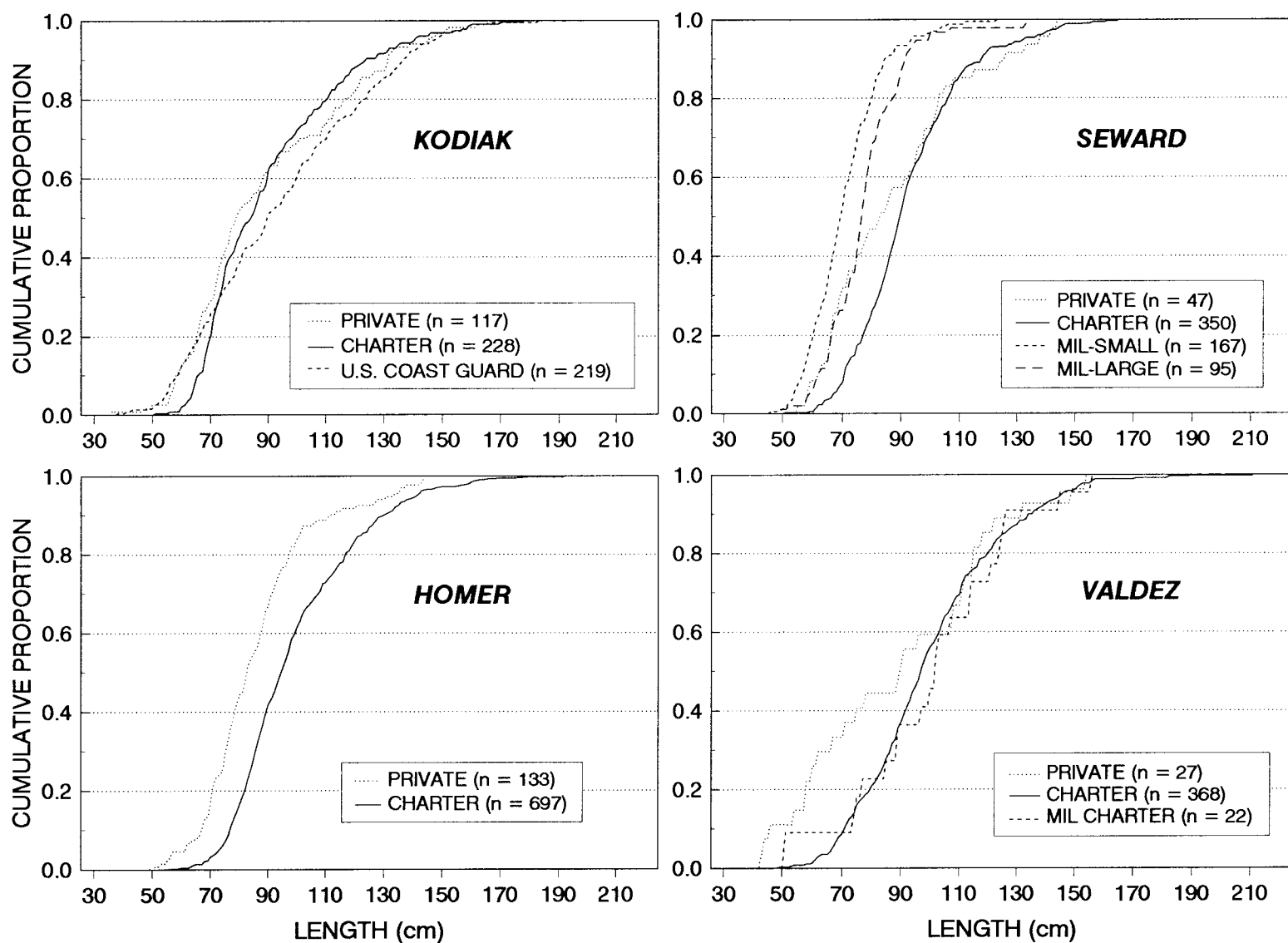


Figure 11. Estimated cumulative length-frequency distribution of the recreational halibut harvest by user group at Kodiak, Homer, Seward, and Valdez in 1993.

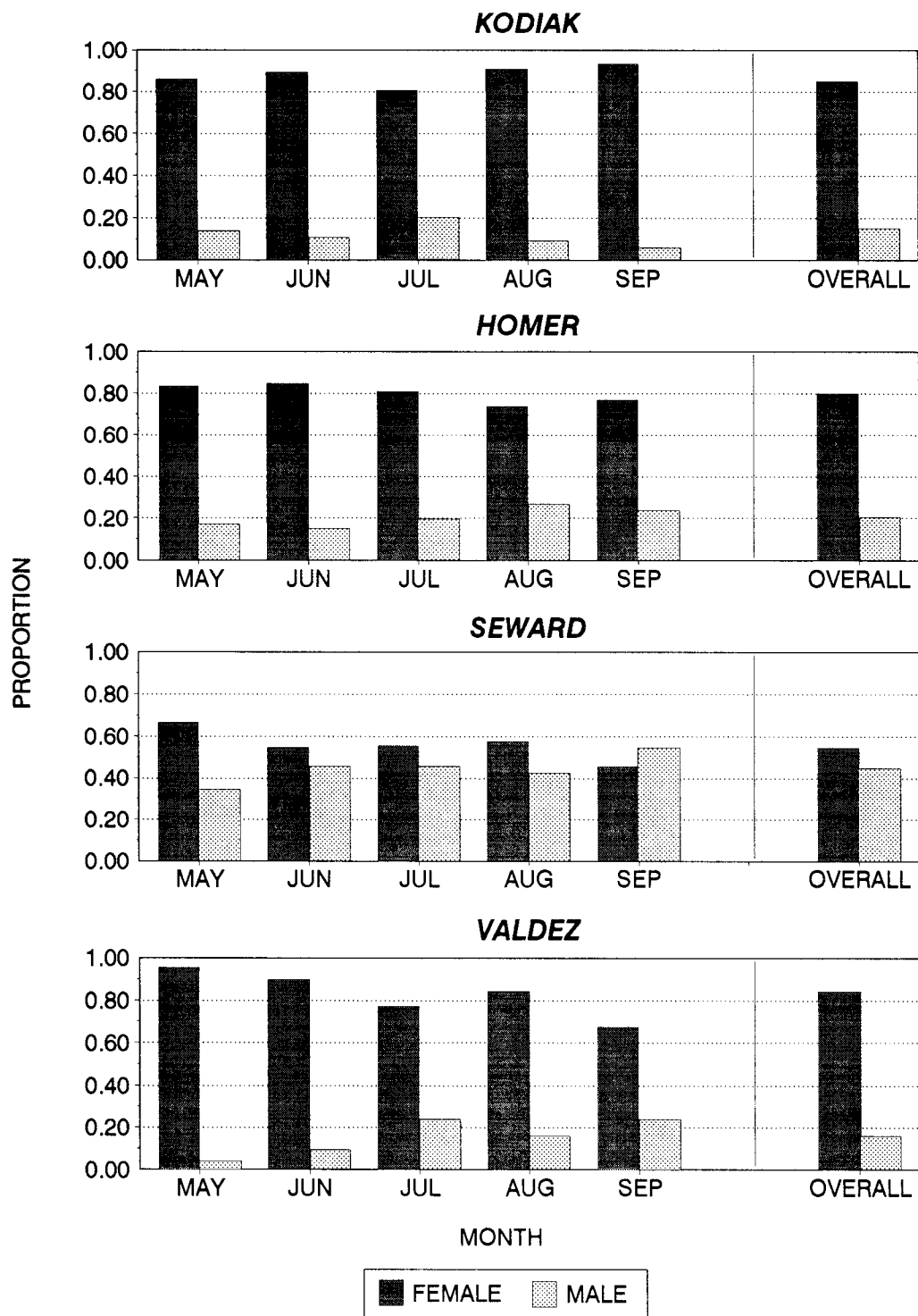


Figure 12. Estimated relative proportions of male and female halibut in the recreational halibut harvest at Kodiak, Homer, Seward, and Valdez in 1993.

There were no significant differences in sex ratio among months at Homer ($\chi^2 = 8.6$, $df = 4$, $P = 0.072$) or Seward ($\chi^2 = 9.2$, $df = 4$, $P = 0.055$). Differences among months were significant at Kodiak ($\chi^2 = 20.1$, $df = 4$, $P < 0.001$) and Valdez ($\chi^2 = 32.5$, $df = 4$, $P < 0.001$). At Kodiak, the proportion of females in the harvest was lowest in July and highest in September. In contrast, females made up a generally higher proportion of the Valdez harvest early in the year, and a much lower proportion later in September. Even though differences were significant among months at Kodiak and Valdez, stratification of overall estimates of sex composition was not necessary. Weighted and unweighted estimates differed by 1.2% at Kodiak and less than 1% at Valdez.

Geographic Distribution of Effort and Harvest

Recreational effort and harvest for halibut were spread over large geographic areas at all ports but Kodiak. Most of the effort and halibut harvest by Kodiak anglers occurred in Chiniak Bay. A total of 1,349 angler-days and 1,215 harvested halibut were observed through an interview sample representing 429 boat-trips. Eighty-three percent of bottomfishing effort and 85% of the halibut harvest was in stat area 525733 (Figure 13, Appendix C4). The most popular areas fished included Buoy 4, Woody Island, and Long Island.

The Homer interview sample included 213 boat-trips representing 1,310 angler-days and an observed harvest of 2,123 halibut. Effort and harvest by Homer boats was spread from the west side of Cook Inlet to Gore Point and south to the Barren Islands (Figure 14). Harvest was concentrated, however, in three stat areas. Stat area 525902 west of Point Adam accounted for 23% of effort and 31% of harvest. Stat area 525931, west of Anchor Point accounted for 14% of effort and 17% of harvest. Finally, stat area 515905 southwest of Elizabeth and Perl Islands accounted for 19% of the effort and 23% of the harvest. In general, charter boats ranged farther from port than private boats.

Interviews with the civilian fleet in Seward included 311 boat-trips representing 1,411 angler-days and a harvest of 1,223 halibut. Effort and harvest by interviewed anglers were spread over a 140 km-long arc from Black Bay west of Seward to Cape Cleare (Figure 15). The bulk of effort and harvest was spread from the Chiswell Islands and Cape Aialik (stat area 495932) eastward through lower Resurrection Bay and Day Harbor (stat area 495938) to Johnstone Bay (stat areas 485933 and 485935). Private and charter boats took advantage of relatively calm seas, spending 22% of effort and taking 28% of the harvest more than 60 km (32 naut. miles) from Seward in the Johnstone Bay area (stat area 485935).

The military fleet reported a total effort for the season of 7,292 angler-days on 822 boat-trips, and a total harvest of 6,487 halibut. Military charter boats generally did not range as far as civilian boats. Military-chartered anglers expended 56% of their effort and took 55% of their harvest in the Chiswell Islands/Cape Aialik area (stat area 495932; Figure 16). The Johnstone Bay area was also popular with military boats, accounting for 21% of their effort and 34% of their halibut harvest.

Finally, the Valdez interview sample represented 1,627 angler-days on 346 boat-trips, and an observed harvest of 1,717 halibut. Effort and harvest by the Valdez fleet were spread throughout Prince William Sound (Figure 17).

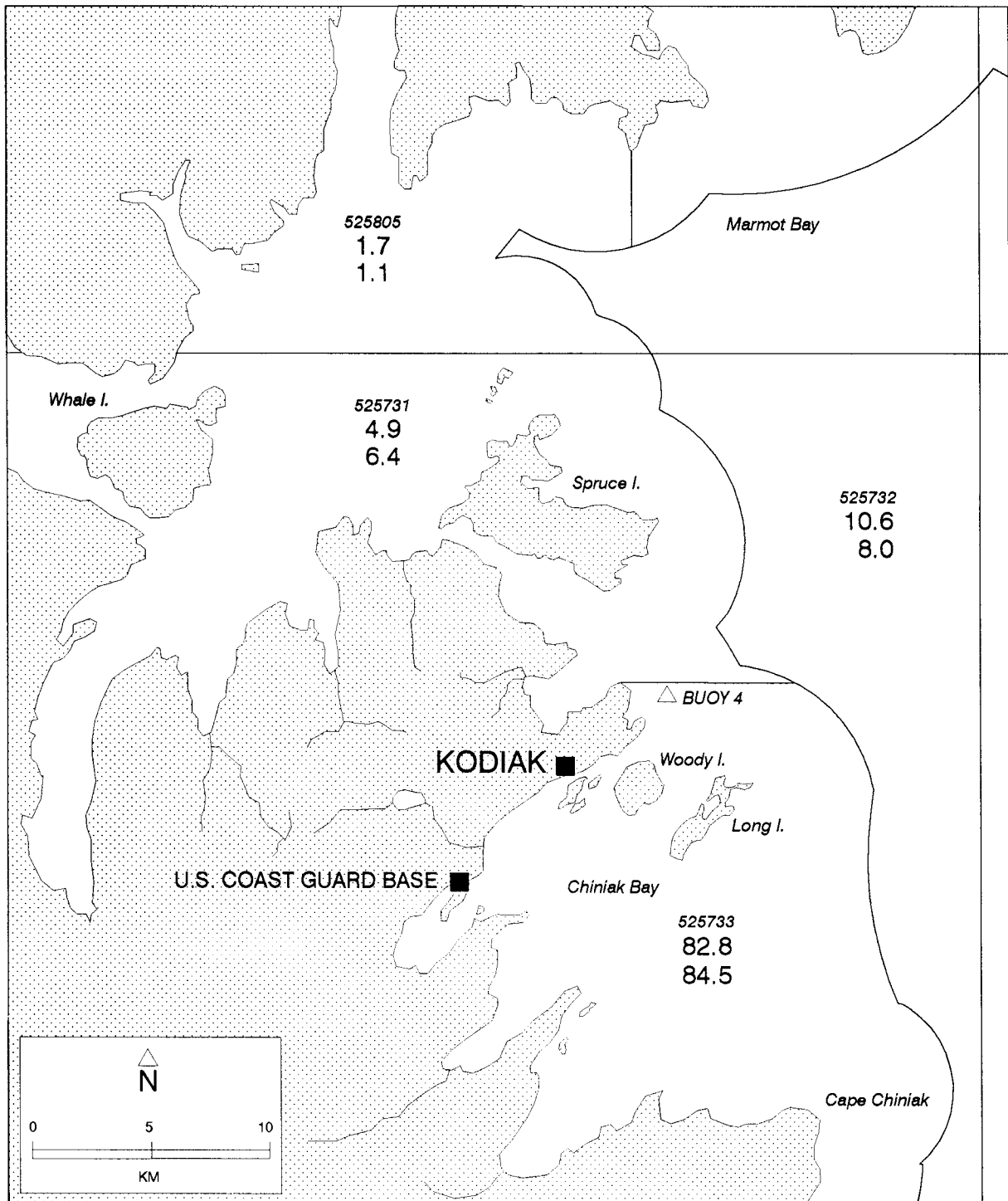


Figure 13. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Kodiak fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).

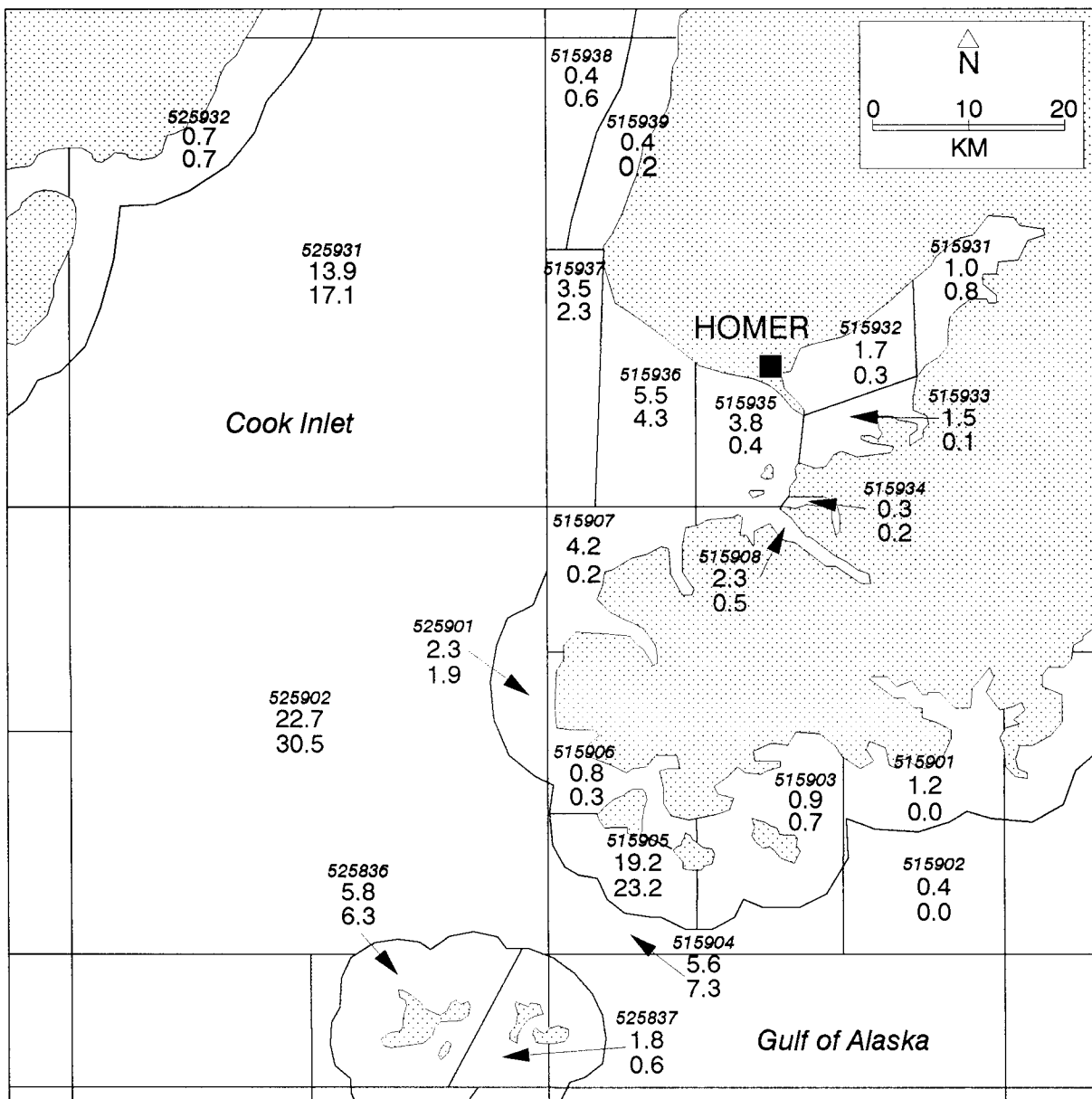


Figure 14. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Homer fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six digit number).

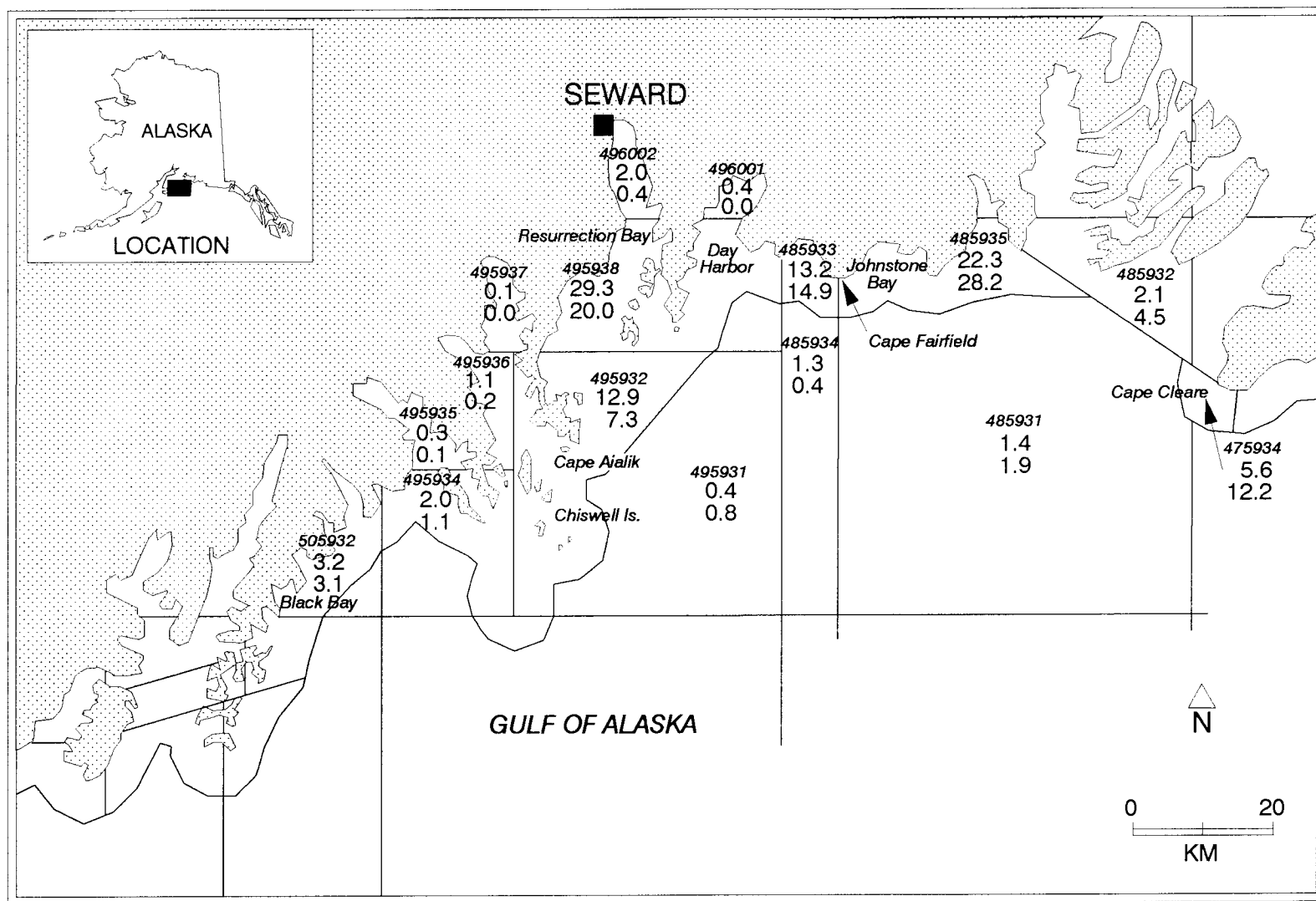


Figure 15. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Seward civilian fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).

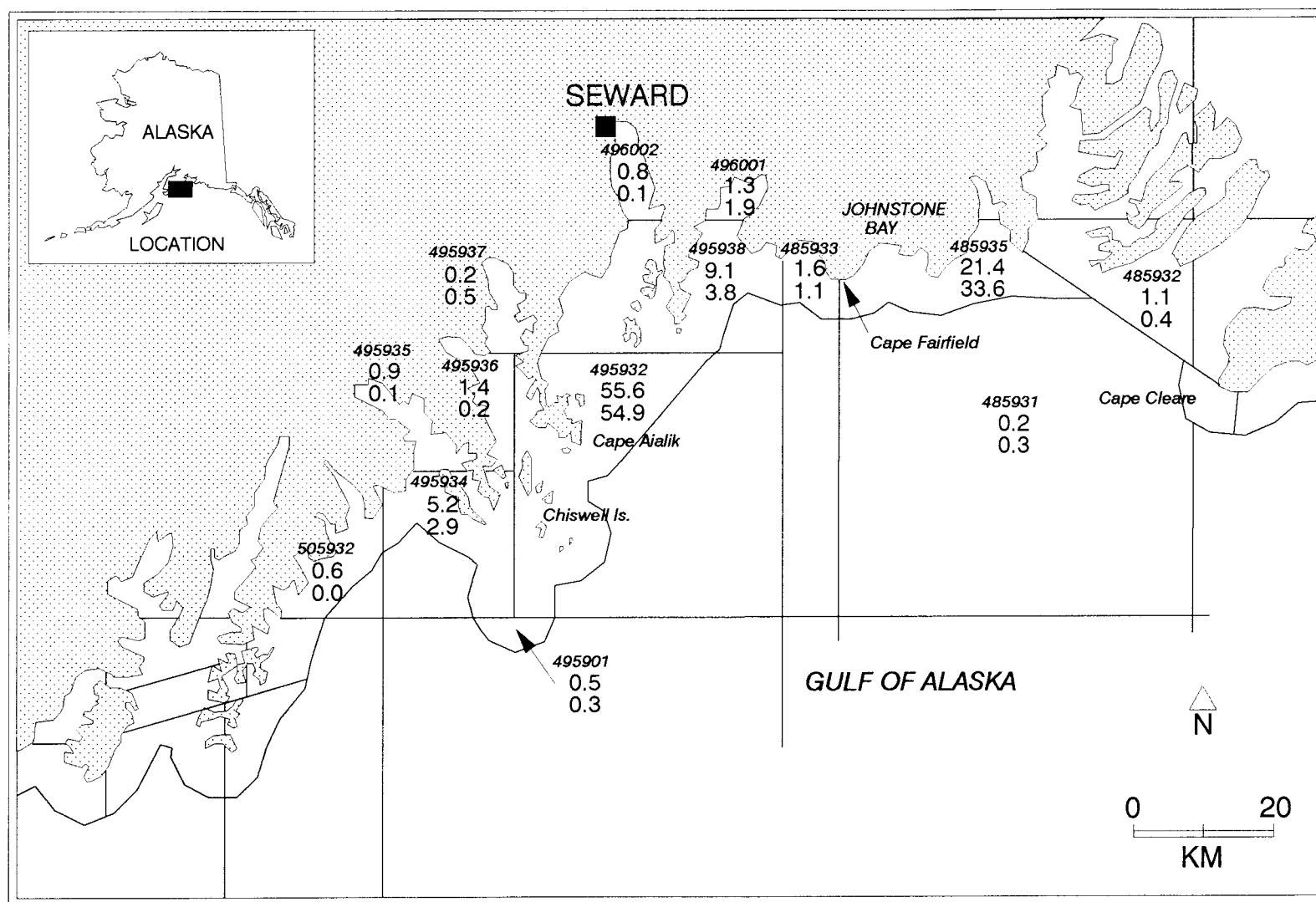


Figure 16. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Seward Military Recreation Camp charter fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).

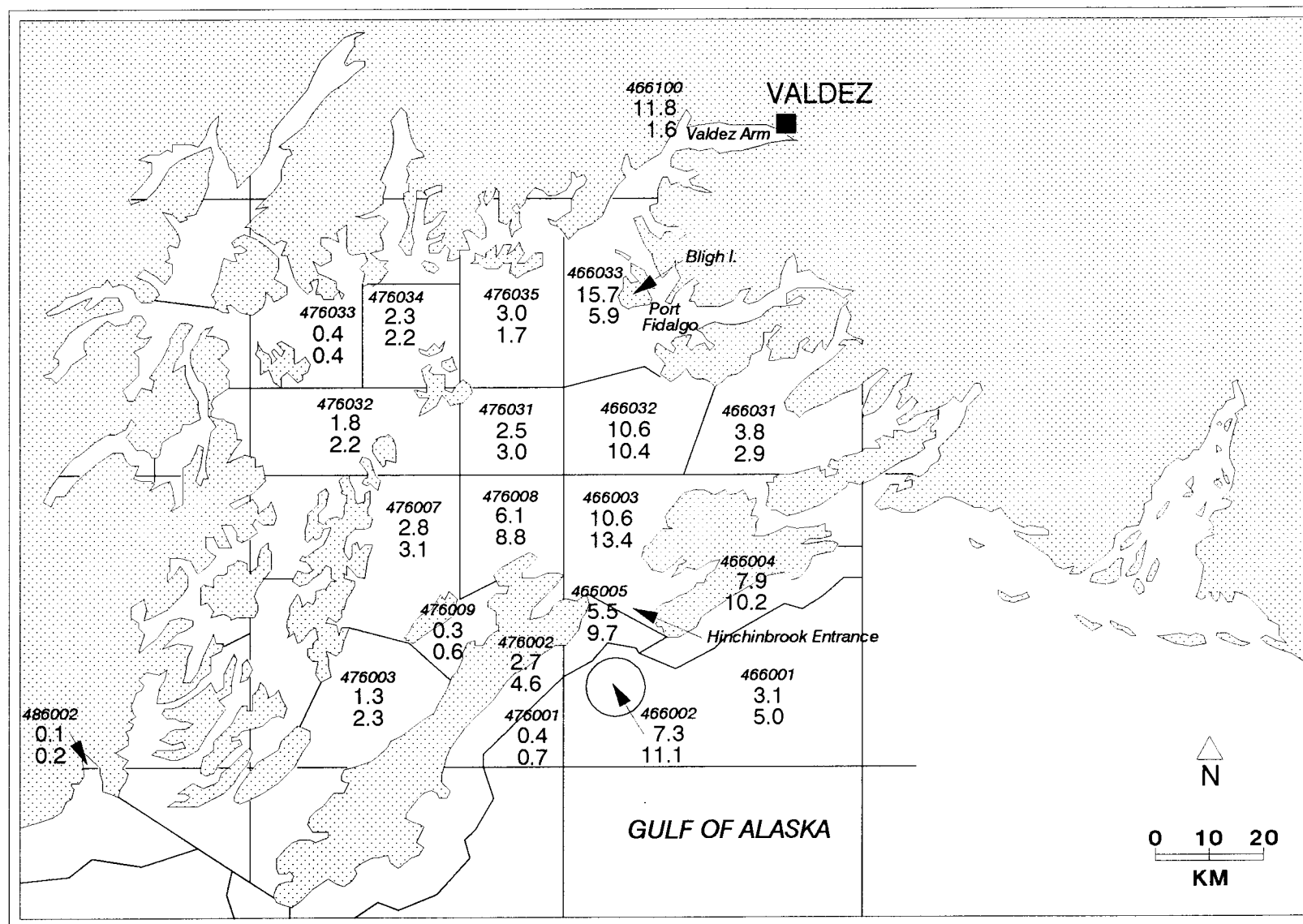


Figure 17. Spatial distribution of recreational bottomfishing effort and halibut harvest by the Valdez fleet in 1993. The percentage of angler-days (upper number) and the percentage of fish harvested (lower number) are shown for each ADF&G statistical area (six-digit number).

Most of the effort and harvest were in a north-south corridor running from Valdez Arm to Hinchinbrook Entrance. Stat area 466033, including Bligh Island and Port Fidalgo, was the most heavily fished area with 16% of the effort but only 6% of the halibut harvest. Surprisingly, 27% of the effort and 41% of the harvest was in six stat areas outside of Hinchinbrook Entrance, more than 100 km (55 naut. miles) from Valdez. Most boats fishing these outside areas were charter boats.

User Group, Target Species, and Gear Type Composition

User Group Composition:

The percentage of effort and halibut harvest attributable to each user group varied by port. In general, chartered anglers were more effective at catching halibut; their proportion of the harvest always exceeded their proportion of the effort (Table 6). For example, chartered anglers at Kodiak only made up 24% of the effort (in angler-days) but took 33% of the harvest (in number of fish). In addition to being more effective, chartered anglers also took the majority of harvest at all other ports. Chartered anglers accounted for 77% of the effort and 88% of the harvest at Homer. Within the civilian fleet at Seward, guided anglers made up only 46% of the effort but took 56% of the harvest. Finally, chartered anglers (civilian and military) at Valdez made up 69% of the effort and took 85% of the harvest.

The military charter fleet at Seward was composed of two groups: (1) anglers fishing from four large boats (43-50 ft), and (2) anglers fishing from eleven small boats (27 ft). Catch rates of the two groups were roughly equivalent. For example, chartered anglers on large boats made up 57% of the effort and 55% of the harvest (Table 6).

Target Species Composition:

Halibut were the primary bottomfish species of interest at all ports. The percentage of angler-days targeted exclusively on halibut ranged from 67% at Seward to just under 100% at Homer (Table 7). Anglers at Kodiak and Seward spent a considerable portion of their effort targeting other species in combination with halibut (18% and 25%, respectively). The percentage of angler-days spent targeting bottomfish other than halibut was highest at Seward (8%).

As expected, anglers targeting halibut exclusively accounted for the majority of the halibut harvest. All of the Homer harvest was by anglers targeting halibut only, compared with 99% at Valdez, 80% at Kodiak, and 77% at Seward (Table 7). About one-fifth of the Kodiak and Seward halibut harvest was by anglers targeting halibut in combination with other bottomfish.

It was impossible to determine the proportion of effort by Seward Military Recreation Camp anglers that was targeted exclusively on halibut. Military charter boat operators recorded target species data as "bottomfish," "salmon," or "both." All of the harvest, and nearly all of the effort (99.7%) fell in the "bottomfish" category. Although camp personnel have indicated in past years that lingcod are a primary target (particularly for small boats), this may be changing somewhat due to recent institution of time and area closures and reduced bag limits in the lingcod fishery.

Table 6. Composition of recreational bottomfishing effort (angler-days) and halibut harvest (number of fish) by user group, southcentral Alaska, 1993.

Port	Number of Boat-Trip Interviews	User Group	Effort		Harvest	
			Percent	SE(%)	Percent	SE(%)
Kodiak	429	Private	43.1	1.3	36.5	1.4
		U.S.C.G. ^a	32.7	1.3	30.3	1.3
		Charter	24.2	1.2	33.2	1.4
Homer	213	Private	23.1	1.2	12.2	0.7
		Charter	76.9	1.2	87.8	1.2
Seward (Civilian)	311	Private	54.0	1.3	43.6	1.4
		Charter	46.0	1.3	56.4	1.4
Seward (Military charters)	822	Large Boats ^b	57.1	0.6	54.7	0.6
		Small Boats ^c	42.9	0.6	45.3	0.6
Valdez	346	Private	31.0	1.1	15.2	0.9
		Mil. Charter	13.0	0.8	9.7	0.7
		Charter	56.0	1.2	75.1	1.0

^a U.S. Coast Guard morale boats (unguided anglers).

^b Seward Military Recreation Camp chartered anglers on large boats (43-50 ft).

^c Seward Military Recreation Camp chartered anglers on small boats (27 ft).

Table 7. Composition of bottomfishing effort (angler-days) and halibut harvest (number of fish) by target species category, southcentral Alaska, 1993. Standard errors of percentages are shown in parentheses. Data are from interviews that included only anglers targeting bottomfish for all or part of their angler-day.

Port	Percent of Effort by Target Category			Percent of Harvest by Target Category		
	Halibut Only	Halibut + Other ^a	Other ^a	Halibut Only	Halibut + Other ^a	Other ^a
Kodiak	81.7 (1.1)	18.3 (1.1)	0	80.2 (1.1)	19.8 (1.1)	0
Homer	99.6 (0.2)	0	0.4 (0.2)	100.0 (0.0)	0	0
Seward (civilian) ^b	66.6 (1.3)	25.2 (1.2)	8.2 (0.7)	76.8 (1.2)	22.4 (1.2)	0.8 (0.3)
Valdez	95.9 (0.5)	2.7 (0.4)	1.5 (0.3)	99.0 (0.2)	0.8 (0.2)	0.2 (0.1)

^a "Other" includes only other bottomfish such as lingcod and rockfish.

^b Seward Military Recreation Camp data are not shown because the camp was asked only to report target species as "bottomfish," "salmon," or "both" (see text).

Gear Type Composition:

Many angler responses did not fit gear type categories used in angler interviews. Anglers employed a wide variety of gear types, and often used several per day or several in conjunction (e.g. baited jig). Gear type categories were therefore simplified to (1) bait only, (2) bait plus other gear types, and (3) other gear types. Bait was clearly the preferred terminal gear type (Table 8). An estimated 67%-98% of the total effort and 70%-99% of the harvest was accounted for by anglers using bait exclusively. In addition, bait accounted for an unknown portion of the effort and harvest in the "bait + other" category.

The Seward Military Recreation Camp recorded gear use as either (1) jig and bait in combination or (2) troll gear. Gear categories for the recreation camp were originally established to evaluate the lingcod fishery. Troll gear accounted for 39% of the recreation camp effort, but much of this effort was probably targeted on lingcod or rockfish. Surprisingly, 27% of the recreation camp halibut harvest was reportedly taken with troll gear.

Effects of a Bag Limit Reduction

Overall, institution of a one-fish daily bag limit would be expected to reduce halibut harvest by about 26% at Kodiak, 45% at Homer, 32% in the civilian fishery at Seward, 28% in the military charter fishery at Seward, and 35% at Valdez (Figure 18). These estimated reductions assume that angler effort would remain constant. The number of halibut harvested could increase if, for example, effort increased as a result of more half-day trips by charter vessels. Biomass of the sport harvest could also rise if anglers responded to a bag limit decrease by preferentially keeping larger fish.

Impacts of a bag limit reduction would be greater for chartered anglers than unguided anglers. Thirty-three percent of the harvest by chartered anglers at Kodiak consisted of second fish in the creel, compared with 22%-24% by unguided anglers on private boats and U.S. Coast Guard morale boats. At Homer, 47% of the harvest by chartered anglers was composed of second fish, compared with 34% by private boat anglers. Civilian charter and private anglers at Seward would probably be affected similarly; 33% of the charter harvest and 31% of the private harvest were second fish. The harvest by chartered anglers on Seward Military Recreation Camp boats would be affected the least. Depending on boat size, 27%-29% of their harvest was made up of second fish, but they tend to target other bottomfish in addition to halibut. Finally, civilian and military charter anglers at Valdez took 38% and 31% of their harvest as second fish, compared with only 23% by unguided anglers.

Tests for Differences in Mean Length-at-Age

The analysis of variance test for differences in mean length-at-age among ports showed a significant interaction between the port and age factors for both sexes (both P-values < 0.001, Table 9). Therefore, mean length-at-age of harvested halibut was not consistently larger or smaller across all ages for any one port (Figure 19). This was true for males and females.

Table 8. Composition of bottomfishing effort (angler-days) and halibut harvest (number of fish) by terminal gear category, southcentral Alaska, 1993. Standard errors of percentages are shown in parentheses.

Port	Percent of Effort by Gear Category			Percent of Harvest by Gear Category		
	Bait Only	Bait + Other ^a	Other ^a	Bait Only	Bait + Other ^a	Other ^a
Kodiak	84.5 (1.0)	13.0 (0.9)	2.5 (0.4)	86.0 (1.0)	12.2 (0.9)	1.8 (0.4)
Homer	98.4 (0.3)	1.20 (0.3)	0.4 (0.2)	98.9 (0.2)	1.1 (0.2)	0
Seward (civilian) ^b	67.3 (1.3)	25.5 (1.2)	7.3 (0.7)	70.2 (1.3)	28.2 (1.3)	1.6 (0.4)
Valdez	94.1 (0.6)	3.0 (0.4)	2.9 (0.4)	92.7 (0.6)	2.8 (0.4)	4.5 (0.5)

^a "Other" includes jig, troll, lure, and fly.

^b Seward Military Recreation Camp data are not shown because the camp was asked only to report gear types as "jig and bait" and "troll" (see text).

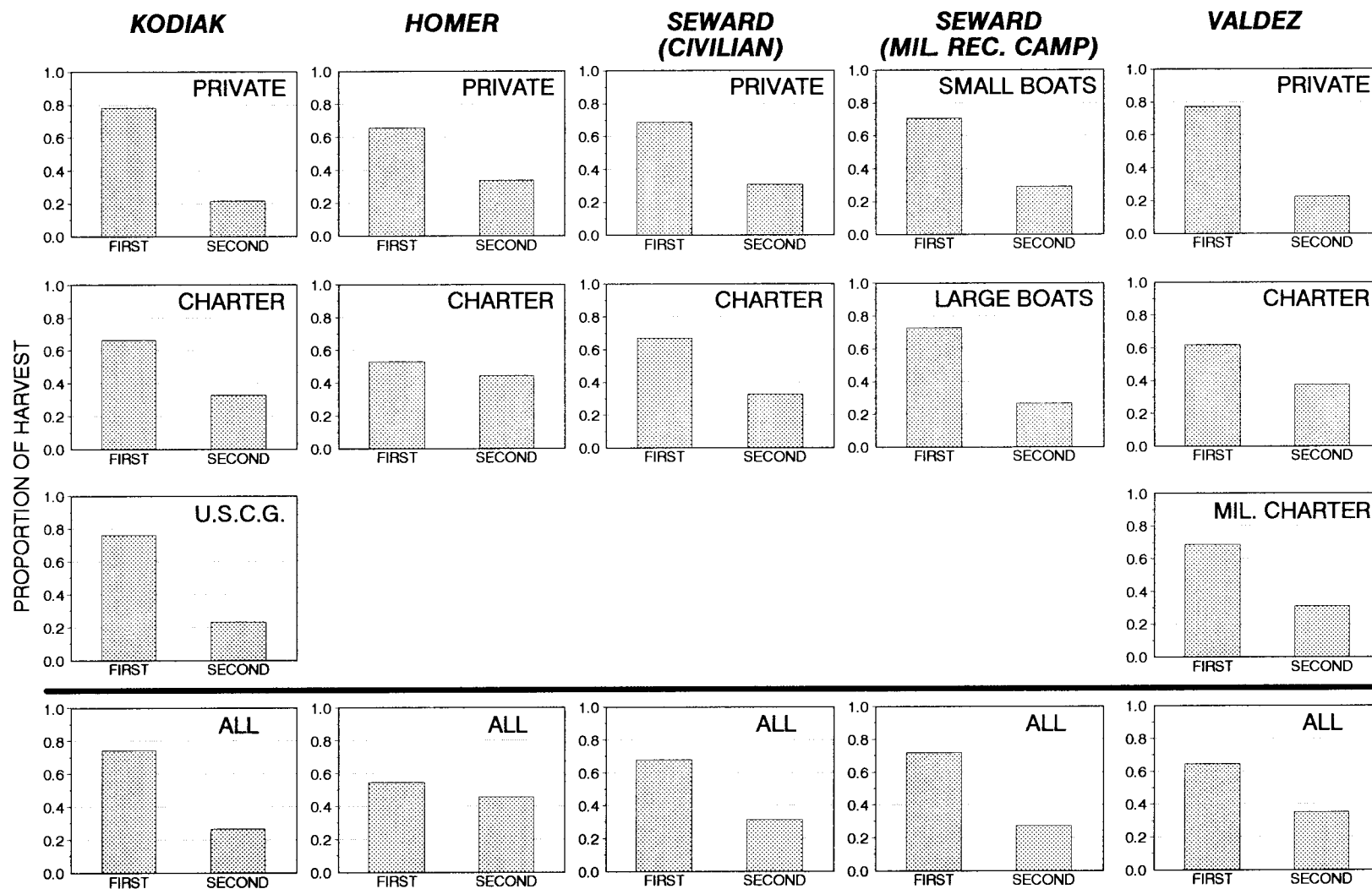


Figure 18. Estimated proportions of the recreational halibut harvest (in number of fish) made up of first and second fish in the bag limit at Kodiak, Homer, Seward, and Valdez in 1993. Graphs above the bold line show proportions by user group, while graphs below the bold line show overall proportions for each fishery.

Table 9. Results of the two-factor analysis of variance test for differences among ports in mean length-at-age of male and female halibut harvested in the Area 3A recreational fishery, 1993.

Sex	Source	DF	Mean Square	F	P-value
Females	Age	17	3,526,457.26	156.42	0.0
	Port	3	154,006.18	6.83	0.0001
	Age x Port	39	84,235.12	3.74	0.0001
	Error	1,984	22,544.13		
	Total	2,043			
Males	Age	13	246,334.91	34.26	0.0001
	Port	3	69,489.86	9.66	0.0001
	Age x Port	30	17,203.71	2.39	0.0001
	Error	617	7,191.02		
	Total	663			

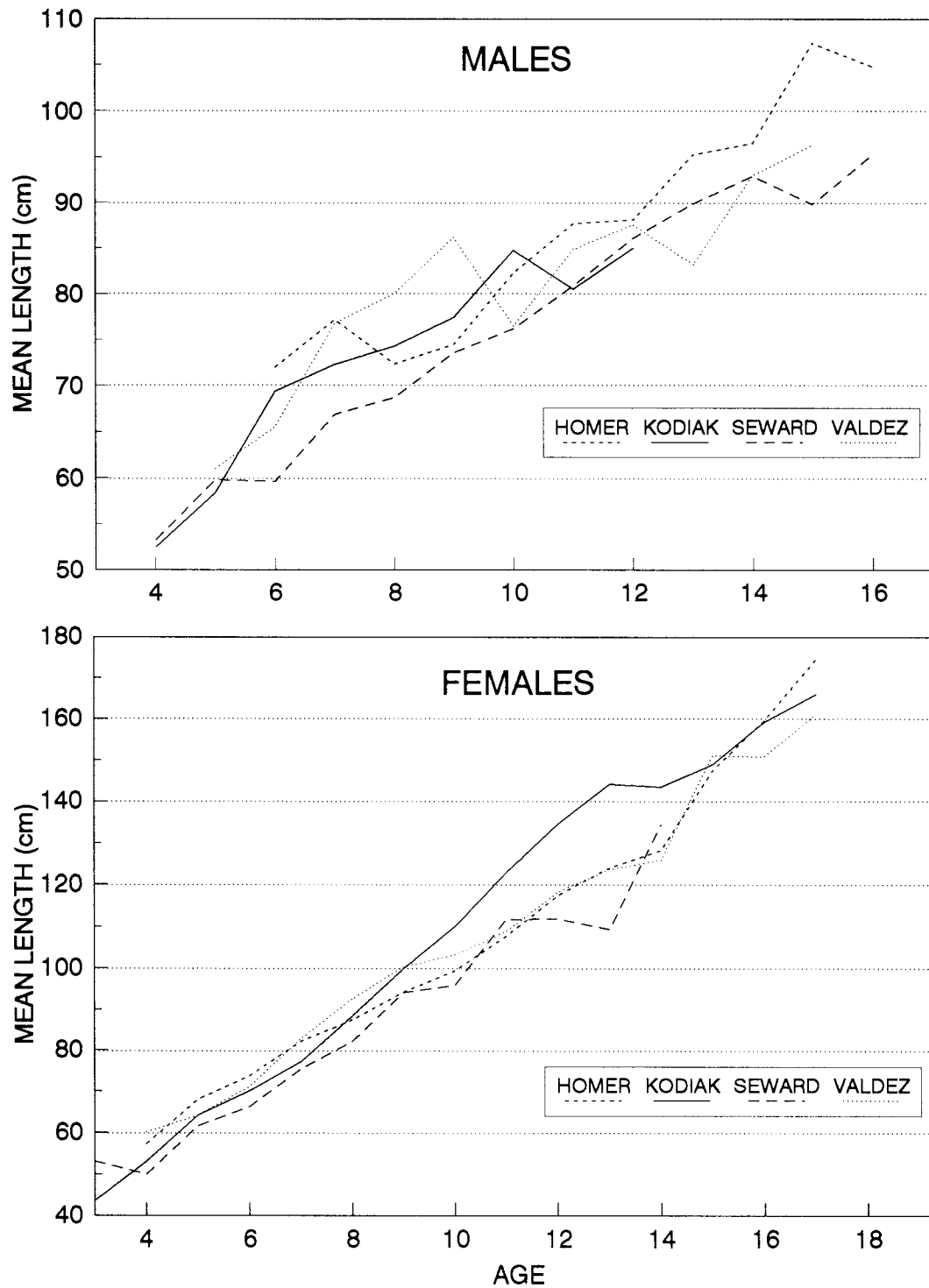


Figure 19. Mean length-at-age of male (top) and female (bottom) halibut harvested in recreational fisheries at Kodiak, Homer, Seward, and Valdez in 1993.

DISCUSSION

Estimates of age, size, and sex composition of the recreational harvest were generally consistent with past years. Modal age groups tracked with 1991 and 1992 data for the most part (Meyer 1992, 1993a). The 1982 year class (age 11) appeared relatively weak at most ports as it did in 1991 and 1992 (Figure 9). As in past years, harvested fish were smaller at Seward than at other ports (Figure 10), and the Seward harvest again had the highest proportion of males (Figure 12).

There were, however, some notable deviations from past data. Halibut harvested at Kodiak in 1993 were considerably smaller and younger than fish taken in 1992 (Meyer 1993a). Ages 5-7 appeared strong relative to recent years and made up a significant portion of the harvest (Figure 9). The study design was altered in 1993 to include sampling of harvest by Coast Guard morale boats. This change, however, probably did not cause the observed reduction in size and age composition because halibut taken on these boats were larger on average than fish taken by other user groups (Figure 11). The strong showing of the 1987 year class (age 6) at Kodiak and Valdez correlates with observation of this strong year class in eastern Bering Sea trawl surveys (Clark and Bakkala 1992).

In contrast, fish taken at Homer were generally older and larger than in past years, and the 1987 year class did not appear particularly strong. At least two explanations are possible. First, a large percentage of the Homer harvest was by chartered anglers, and landings by chartered anglers include few small halibut. This apparent selectivity for larger fish may be due in part to encouragement by charter crews to release small fish, and also in part to cleaning of small halibut at sea. Some charter operators clean small fish at sea to expedite meat handling and return to port with the largest fish for weighing and photographs. If a significant portion of the harvest was in fact small fish cleaned at sea, then length, weight, and age parameters for Homer were overestimated. Even though most of the harvest of fish under 70 cm (ages 5-7) was by unguided anglers (Figure 11), the 1987 year class should still appear strong relative to adjacent age classes. The eventual appearance of this year class in the Cook Inlet harvest may provide information on recruitment mechanisms in this fishery.

Surprising results were obtained with respect to the sizes of fish caught by various user groups. Private (unguided) anglers at Seward caught more large halibut in 1993 than in 1992, probably because of improved boating conditions. The Gulf of Alaska was relatively calm, particularly in July, and private boats fished farther from Seward than in past years. Most military charter boats at Seward continued to fish the lower Resurrection Bay and Chiswell Islands area, and the length composition of their harvest was similar to last year but smaller than that of private anglers. At Kodiak, unguided U.S. Coast Guard personnel generally caught larger halibut than other anglers, but fewer of them kept two fish per day. This is surprising because Coast Guard "morale boats" are restricted to only the nearshore portion of Chiniak Bay.

The ADF&G statewide postal survey (e.g. Mills 1993) provides data to estimate harvest by private and chartered anglers only in the Cook Inlet and North Gulf Coast fisheries (Figure 4). Interviews for this study provided not only estimates for Kodiak and Valdez, but also allowed comparisons of interview

data and postal survey data for the Cook Inlet and North Gulf fisheries. For example, interview data from Homer show that 88% of the harvest was by chartered anglers (Table 6), compared with postal survey estimates of 50%-68% for the Lower Cook Inlet fishery during the period 1986-1992 (Figure 4). This difference is probably due to the fact that port sampling was conducted only within the Homer harbor during the summer months, while the postal survey includes harvest from all boats accessing the fishery at all points during all times of year. In another comparison, interview data indicate that 63% of the Seward harvest was taken by chartered anglers, assuming that military charter boats accounted for 16% of the Seward harvest as they did in 1992. This is slightly higher than the postal survey estimates of 36%-55% for 1986-1992 (Figure 4). This is understandable given the recent modest growth in the Seward charter fleet. Finally, chartered anglers at Valdez took an estimated 69% of the harvest in 1993. This estimate too is understandably higher than the only previous estimate of 58% in 1988 (Roth and Delaney 1989), given that the charter fleet has grown. Charter operators are under financial pressure to produce halibut, while private boat anglers often spend a good portion of their angling day boating, sightseeing, or targeting other species.

The target species and gear composition estimates obtained were previously not available for any Area 3A fisheries. The most important conclusions from these data are that (1) halibut are the primary bottomfish targeted at all ports, (2) bait is the primary terminal tackle used, and (3) compared with other ports, more anglers at Seward target bottomfish other than halibut and use gear types other than bait. These results are not suitable for any rigorous statistical assessment of fishery selectivity. Because target and gear type categories included combinations of species or gears, the exact proportions attributable to each could not be determined. Anglers often targeted several species with a mixture of gears throughout their angler-day. This observation points out the potential difficulty of estimating effective effort by species.

The precision of nearly all parameter estimates obtained in 1993 was high. Estimates of the proportion of the harvest in each age and length group were within 3.2% (with 95% confidence). Estimates of sex ratio were within 3.6%, and estimates of mean net weight were within 3.1 lb at Homer and 1.7 lb at other ports (with 95% confidence). All estimates are limited to the ports sampled and waters fished by their respective fleets, but these ports represent a substantial portion of Area 3A landings.

There does not appear to be any immediate need to estimate halibut harvest throughout Area 3A using onsite creel surveys. The 1992 postal survey estimate for Area 3A was within about 3% of the true harvest with 95% confidence (Mike Mills, ADF&G, Anchorage, personal communication). This level of precision is certainly more than adequate under the current management system. Onsite creel surveys would only be necessary for inseason harvest management and are unlikely to provide better estimates than the postal survey. For example, a creel survey planned for the Deep Creek halibut and chinook salmon fishery in 1994 is expected to achieve a relative precision of 15%; recent postal survey estimates for the same fishery achieved a relative precision of 11% (T. McKinley, ADF&G, Soldotna, personal communication). Given the large number of possible access points throughout Area 3A, the cost of designing and implementing onsite surveys could be potentially prohibitive.

RECOMMENDATIONS

The sampling design was changed in 1993 to allocate time specifically for biological sampling and conducting interviews. Separation of these activities was very beneficial—samplers were allowed to focus on the task at hand, and more and better biological and angler interview data were collected. Although desired sample sizes and levels of precision and accuracy were achieved, some minor sampling problems remain. Interview sampling rates at Homer and Seward should be increased in 1994 to increase precision of estimates. Future study should evaluate the potential bias resulting from at-sea cleaning of small halibut, particularly at Homer. Data forms for the Seward Military Recreation Camp should be modified to conform exactly with interview data collected by port samplers.

Recent changes in effort and harvest in the Central Cook Inlet halibut fishery warrant resumption of data collection in that area. Age, size, and sex composition were estimated for the Deep Creek harvest in 1991, but sampling was not conducted in 1992 and 1993 because there were no functional differences in age or size composition between Homer and Deep Creek. The fishery has grown and changed through an influx of guided effort. Because the fishery now makes up a major portion of the Area 3A recreational harvest, accurate estimates of age composition and mean weight are needed. In addition, data on fishery characteristics and areas fished would provide insight for management and assessment of localized resource depletion.

ACKNOWLEDGEMENTS

Numerous Department of Fish and Game personnel contributed to this study and report. Catherine Coon, Alan Heckart, William Romberg, and Michael Parish collected biological and interview data, validated results through personal observations, and assisted the public on a daily basis. Paul Cyr aged all halibut otoliths and assisted with figures. William Romberg assisted with data reduction and preparation of tables and figures. James Hasbrouck assisted with operational planning, and Pat Hansen analyzed the mean length-at-age data and provided valuable biometric guidance and interpretation. Paul Suchanek and Doug McBride provided editorial insight and Margaret Leonard whipped the report into publishable form. Finally Doug Vincent-Lang provided overall project guidance, supervision, and perspective.

Other individuals were instrumental in the study. Calvin Blood of the IPHC once again shared his wealth of knowledge of halibut aging. Jack Dyer and staff of the Seward Military Recreation Camp generously provided daily harvest records and sampling facilities. Commander Troth and other U.S. Coast Guard personnel allowed onbase sampling of recreational harvest at Kodiak. Harbor-masters throughout the region provided valuable advice for planning and sampling. Most importantly, this project would have been impossible without the cooperation of the angling public. The vast majority of anglers and charter boat operators were generous with information and facilities, courteous, and genuinely concerned for the halibut resource.

LITERATURE CITED

- Chilton, D. E. and R. J. Beamish. 1982. Age determination methods for fishes studied by the groundfish program at the Pacific Biological Station. Canadian Special Publication of Fisheries and Aquatic Sciences No. 60. Department of Fisheries and Oceans, Resource Services Branch, Pacific Biological Station, Nanaimo, B.C.
- Clark, W. G. 1992. Validation of the IPHC length-weight relationship for halibut. Pages 113-116 in Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.
- Clark, W. G. and R. G. Bakkala. 1992. Trends in abundance of juvenile halibut indicated by NMFS trawl surveys. Pages 133-138 in Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.
- Cochran, W. G. 1977. Sampling techniques (third edition). John Wiley and Sons, New York.
- Conover, W. J. 1980. Practical nonparametric statistics. John Wiley and Sons, New York.
- Coughenower, D. 1986. Homer, Alaska charter fishing industry study. University of Alaska, Marine Advisory Program, Bulletin No. 22. Anchorage.
- Denny, C. 1990. Derby days. Alaska Business Monthly 6:47-53.
- IPHC (International Pacific Halibut Commission). 1987. The Pacific halibut: biology, fishery, and management. Technical Report No. 22. International Pacific Halibut Commission, Seattle, Washington.
- Jones & Stokes Associates, Inc. 1987. Southcentral Alaska sport fishing economic study. Final research report. November 1987. (JSA86-0413.) Sacramento, California. Prepared for Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Section, Anchorage.
- Meyer, S. C. 1992. Biological characteristics of the sport harvest of marine groundfishes in southcentral Alaska, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-41, Anchorage.
- _____. 1993a. Biological characteristics of the sport harvest of Pacific halibut in southcentral Alaska, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-18, Anchorage.
- _____. 1993b. Assessment of the recreational harvest and fishery for lingcod in southcentral Alaska. Alaska Department of Fish and Game, Fishery Data Series No. 93-33, Anchorage.
- Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (SW-1-A), Juneau.

LITERATURE CITED (Continued)

- _____. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-1-A), Juneau.
- _____. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.
- _____. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.
- _____. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (SW-1-A), Juneau.
- _____. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24 (SW-1-A), Juneau.
- _____. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-1-A), Juneau.
- _____. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (SW-1-A), Juneau.
- _____. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (RT-2), Juneau.
- _____. 1987. Alaska statewide sport fisheries harvest report 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.
- _____. 1988. Alaska statewide sport fisheries harvest report 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.
- _____. 1989. Alaska statewide sport fisheries harvest report 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.
- _____. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.
- _____. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.
- _____. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage.

LITERATURE CITED (Continued)

- _____. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage.
- Mills, M. J. and A. L. Howe. 1992. An evaluation of estimates of sport fish harvest from the Alaska statewide mail survey. Alaska Department of Fish and Game, Special Publication No. 92-2, Anchorage.
- Nielsen, L. A. and W. F. Schoch. 1980. Errors in estimating mean weight and other statistics from mean length. Transactions of the American Fisheries Society 109:319-322.
- Roth, K. J. 1990. Prince William Sound and Gulf of Alaska sport fishery harvest and effort, 1989. Alaska Department of Fish and Game, State/Federal Resource Damage Assessment Data Summary Report, Fish/Shellfish Study No. 6 (*Exxon Valdez Oil Spill*), Anchorage.
- Roth, K. J. and K. J. Delaney. 1989. Creel statistics for the Valdez Arm and Eshamy Bay sport fisheries of Prince William Sound, Alaska, during 1988. Alaska Department of Fish and Game, Fishery Data Series No. 103, Juneau.
- Scholz, F. W. and M. A. Stephens. 1987. K-sample Anderson-Darling test. Journal of the American Statistical Association 82:918-924.
- Sullivan, P. J. 1993. Population assessment, 1992. Pages 33-45 in Report of assessment and research activities, 1992. International Pacific Halibut Commission, Seattle, Washington.
- Sullivan, P. J., A. M. Parma, and B. A. Vienneau. 1992. Population assessment, 1991, technical supplement. Pages 53-69 in Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.
- Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41:42-46.
- Vincent-Lang, D. 1991. Age, length, and species compositions of groundfish harvested in the marine sport fisheries of Resurrection Bay, Alaska, 1988-1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-28, Anchorage.

APPENDIX A

Appendix A1. Estimated recreational fishing effort, by fishery^a, for all saltwater finfish in IPHC Regulatory Area 3A, 1979-1992 (Mills 1981a-1993).

Year	Number of Angler-Days by Fishery					Total Area 3A	Statewide	Percent of Statewide Effort From Area 3A
	Kodiak	Cook Inlet	North Gulf Coast	PWS	Yakutat			
1979	23,124	100,084	45,875	33,939	911	203,933	387,558	52.6
1980	27,646	89,734	50,753	31,317	985	200,435	404,681	49.5
1981	29,857	95,332	57,833	33,669	1,505	218,196	435,933	50.1
1982	41,113	93,987	50,802	30,826	2,371	219,099	467,380	46.9
1983	40,217	154,608	45,448	36,063	3,524	279,860	543,383	51.5
1984	34,213	141,753	45,171	40,670	2,540	264,347	554,712	47.7
1985	33,032	125,084	55,153	66,291	1,193	280,753	565,119	49.7
1986	31,762	147,785	53,007	51,681	1,303	285,538	578,027	49.4
1987	38,671	190,808	43,538	69,425	4,953	347,395	650,120	53.4
1988	30,522	189,619	51,041	78,367	2,494	352,043	675,479	52.1
1989	35,485	168,083	49,839	80,119	1,470	334,996	708,028	47.3
1990	34,969	225,314	70,819	98,000	2,030	431,132	824,190	52.3
1991	42,315	212,634	72,855	102,927	5,142	435,873	829,161	52.6
1992	36,485	231,719	82,615	98,223	4,145	453,187	913,458	49.6

^a See text for description of local fisheries.

Appendix A2. Estimated recreational harvest of Pacific halibut, by fishery^a, in IPHC Regulatory Area 3A, 1977-1992 (Mills 1979-1993).

Year	Number of Halibut Harvested by Fishery					Total Area 3A	Statewide	Percent of Statewide Harvest From Area 3A
	Kodiak	Cook Inlet	North Gulf Coast	PWS	Yakutat			
1977	994	13,466	1,705	1,247	428	17,840	23,244	76.8
1978	1,721	25,577	2,723	933	24	30,978	37,085	83.5
1979	3,013	26,997	2,902	1,691	78	34,681	47,705	72.7
1980	3,651	29,985	3,017	3,143	34	39,830	64,658	61.6
1981	6,858	38,721	3,443	2,495	65	51,582	74,212	69.5
1982	9,180	39,532	2,954	2,735	398	54,799	92,358	59.3
1983	8,545	60,126	2,619	3,493	682	75,465	117,042	64.5
1984	8,179	61,202	3,267	4,428	241	77,317	124,950	61.9
1985	7,303	63,158	5,934	4,527	520	81,442	127,634	63.8
1986	10,960	85,153	10,398	8,331	777	115,619	160,885	71.9
1987	9,869	78,431	7,171	4,379	1,194	101,044	145,829	69.3
1988	7,749	137,252	11,696	9,845	1,673	168,215	225,106	74.7
1989	10,435	126,917	7,251	8,697	772	154,072	229,016	67.3
1990	9,134	148,538	9,500	10,851	1,459	179,482	247,202	72.6
1991	12,089	148,646	13,818	12,733	2,112	189,398	266,523	71.1
1992	10,860	143,094	18,595	17,855	1,861	192,265	264,943	72.6

^a See text for description of local fisheries.

Appendix A3. Estimation of recreational harvest biomass in IPHC Regulatory Area 3A, 1990-1992.

Year/Fishery	Mean Net Weight (lb)	Number of Fish	Harvest (lb)	Data Source for Mean Weight ^a
1990:				
Kodiak	22.5	9,134	205,058	1991 Homer
Central, W. Cook Inlet	22.0	54,597	1,199,496	1991 Deep Creek
Lower Cook Inlet	22.5	93,941	2,108,975	1991 Homer
North Gulf Coast	19.3	9,500	183,540	1990 Seward
Prince William Sound	21.1	10,851	228,739	1990 Valdez
Yakutat	21.1	1,459	30,756	1990 Valdez
Wtd Mean:	22.0	179,482	3,956,565	
1991:				
Kodiak	27.1	12,089	327,733	1992 Kodiak
Central, W. Cook Inlet	22.0	58,648	1,288,497	1991 Deep Creek
Lower Cook Inlet	22.5	89,998	2,020,455	1991 Homer
North Gulf Coast	20.7	13,818	285,756	1991 Seward
Prince William Sound	23.0	12,733	292,604	1991 Valdez
Yakutat	23.0	2,112	48,534	1991 Valdez
Wtd Mean:	22.5	189,398	4,263,579	
1992:				
Kodiak	27.1	10,860	294,415	1992 Kodiak
Central, W. Cook Inlet	19.9	61,643	1,224,846	1992 Homer
Lower Cook Inlet	19.9	81,451	1,618,431	1992 Homer
North Gulf Coast	15.9	18,595	295,475	1992 Seward
Prince William Sound	23.6	17,855	421,557	1992 Valdez
Yakutat	23.6	1,861	43,938	1992 Valdez
Wtd Mean:	20.3	192,265	3,898,662	

^a Estimates of mean weight were not available for all ports in all years.

APPENDIX B

Appendix B. Names and contents of 1993 halibut biological and interview data files archived with ADF&G, Division of Sport Fish, Anchorage.

Filename	Description
Q7540BA3.DTA	Kodiak biological data
10030BA3.DTA	Homer biological data
10020BA3.DTA	Seward biological data
J0010BA3.DTA	Valdez biological data
KODINT93.WK1	Kodiak interview data
HOMINT93.WK1	Homer interview data
SEWINT93.WK1	Seward interview data (civilian fleet)
SEWMIL93.WK1	Seward Military Recreation Camp logbook
VALINT93.WK1	Valdez interview data

APPENDIX C

Appendix C1. Observed frequencies and proportions, by age class, of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1993.

Age	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
KODIAK:													
3		1				1		0.007				0.001	0.001
4	3		2	1		7	0.022	0.007	0.007	0.007		0.009	0.003
5	19	7	18	10	7	61	0.140	0.052	0.059	0.070	0.119	0.078	0.010
6	18	16	47	26	10	117	0.132	0.119	0.154	0.182	0.169	0.150	0.013
7	16	18	35	12	6	87	0.118	0.133	0.115	0.084	0.102	0.112	0.011
8	24	13	40	20	5	102	0.176	0.096	0.131	0.140	0.085	0.131	0.012
9	26	28	54	28	10	146	0.191	0.207	0.177	0.196	0.169	0.188	0.014
10	11	22	51	25	7	116	0.081	0.163	0.167	0.175	0.119	0.149	0.013
11	10	13	24	9	5	61	0.074	0.096	0.079	0.063	0.085	0.078	0.010
12	6	7	14	7	5	39	0.044	0.052	0.046	0.049	0.085	0.050	0.008
13	3	3	12	2	1	21	0.022	0.022	0.039	0.014	0.017	0.027	0.006
14		6	6	2	2	16		0.044	0.020	0.014	0.034	0.021	0.005
15			2			2			0.007			0.003	0.002
16													
17					1	1					0.017	0.001	0.001
18				1		1				0.007		0.001	0.001
	136	135	305	143	59	778	1.000	1.000	1.000	1.000	1.000	1.000	
HOMER:													
4					2	2					0.027	0.003	0.002
5	1	4	4	4	4	17	0.007	0.029	0.015	0.027	0.054	0.022	0.005
6	6	3	6	9	6	30	0.043	0.022	0.023	0.061	0.081	0.039	0.007
7	15	10	13	16	11	65	0.108	0.072	0.050	0.109	0.149	0.085	0.010
8	21	12	18	18	8	77	0.151	0.086	0.069	0.122	0.108	0.101	0.011
9	18	21	27	25	15	106	0.129	0.151	0.103	0.170	0.203	0.139	0.013
10	32	30	57	26	12	157	0.230	0.216	0.218	0.177	0.162	0.206	0.015
11	18	19	33	14	6	90	0.129	0.137	0.126	0.095	0.081	0.118	0.012
12	12	16	32	17	4	81	0.086	0.115	0.122	0.116	0.054	0.106	0.011
13	10	11	32	8	3	64	0.072	0.079	0.122	0.054	0.041	0.084	0.010
14	1	7	17	7	2	34	0.007	0.050	0.065	0.048	0.027	0.045	0.007
15	3	4	14	1		22	0.022	0.029	0.053	0.007		0.029	0.006
16		1	7	1	1	10		0.007	0.027	0.007	0.014	0.013	0.004
17	1	1	2	1		5	0.007	0.007	0.008	0.007		0.007	0.003
18													
19	1					1	0.007					0.001	0.001
	139	139	262	147	74	761	1.000	1.000	1.000	1.000	1.000	1.000	

-continued-

Appendix C1. (Page 2 of 2).

Age	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
SEWARD:													
3		1				1		0.007				0.001	0.001
4		1	1	1	2	5		0.007	0.005	0.007	0.017	0.007	0.003
5	4	7	7	11		29	0.048	0.049	0.033	0.076		0.042	0.008
6	8	12	18	16	6	60	0.096	0.085	0.086	0.110	0.052	0.086	0.011
7	10	26	19	10	4	69	0.120	0.183	0.090	0.069	0.035	0.099	0.011
8	15	31	23	17	4	90	0.181	0.218	0.110	0.117	0.035	0.129	0.013
9	14	24	47	26	6	117	0.169	0.169	0.224	0.179	0.052	0.168	0.014
10	16	21	38	21	11	107	0.193	0.148	0.181	0.145	0.096	0.154	0.014
11	7	5	25	6	8	51	0.084	0.035	0.119	0.041	0.070	0.073	0.010
12	6	9	11	12	24	62	0.072	0.063	0.052	0.083	0.209	0.089	0.011
13	1	1	12	15	24	53	0.012	0.007	0.057	0.103	0.209	0.076	0.010
14	2	1	8	5	7	23	0.024	0.007	0.038	0.034	0.061	0.033	0.007
15		2	1	2	12	17		0.014	0.005	0.014	0.104	0.024	0.006
16		1		1	6	8		0.007		0.007	0.052	0.012	0.004
17		1		2	1	3				0.014	0.009	0.004	0.002
	83	142	210	145	115	695	1.000	1.000	1.000	1.000	1.000	1.000	
VALDEZ:													
4		1	7	1	2	11		0.008	0.028	0.008	0.047	0.018	0.005
5		2	4	5	2	13		0.016	0.016	0.040	0.047	0.022	0.006
6	3	10	20	16	2	51	0.051	0.079	0.818	0.127	0.047	0.085	0.011
7	1	13	20	5	2	41	0.017	0.102	0.081	0.040	0.047	0.068	0.010
8	9	17	36	14	4	80	0.153	0.134	0.146	0.111	0.093	0.133	0.014
9	10	20	40	19	10	99	0.169	0.157	0.163	0.151	0.233	0.165	0.015
10	9	23	48	23	7	110	0.153	0.181	0.195	0.183	0.163	0.183	0.016
11	11	16	25	10	5	67	0.186	0.126	0.102	0.079	0.116	0.111	0.013
12	6	9	21	18	1	55	0.102	0.071	0.085	0.143	0.023	0.092	0.012
13	6	8	11	9	5	39	0.102	0.063	0.045	0.071	0.116	0.065	0.010
14	1	2	3	4		10	0.017	0.016	0.012	0.032		0.017	0.005
15		2	7		3	12		0.016	0.028		0.070	0.020	0.006
16	1	3	1	1		6	0.017	0.024	0.004	0.008		0.010	0.004
17	2		2	1		5	0.034		0.008	0.008		0.008	0.004
18		1				1		0.008				0.002	0.002
19						0							
20			1			1			0.004			0.002	0.002
	59	127	246	126	43	601	1.000	1.000	1.000	1.000	1.000	1.000	

Appendix C2. Observed frequencies and proportions, by length class, of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1993. The total proportions by length class for Homer are weighted estimates (see Results section).

Length Class ^a	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
KODIAK:													
30		2				2		0.004				0.002	0.001
40	1	3		3		7	0.005	0.006		0.017		0.006	0.002
50	15	32	14	7		68	0.079	0.064	0.043	0.039		0.054	0.006
60	38	56	53	24	18	189	0.199	0.112	0.162	0.135	0.237	0.149	0.010
70	37	108	84	40	11	279	0.194	0.217	0.253	0.225	0.145	0.220	0.012
80	21	61	37	28	5	152	0.110	0.122	0.113	0.157	0.066	0.120	0.009
90	22	49	31	25	6	133	0.115	0.098	0.095	0.140	0.079	0.105	0.009
100	17	57	25	10	10	119	0.089	0.114	0.076	0.056	0.132	0.094	0.008
110	9	40	28	15	7	99	0.047	0.080	0.085	0.084	0.092	0.078	0.008
120	15	35	20	6	5	81	0.079	0.070	0.061	0.034	0.066	0.064	0.007
130	6	30	15	7	2	60	0.031	0.060	0.046	0.039	0.026	0.047	0.006
140	5	15	16	6	4	46	0.026	0.030	0.049	0.034	0.053	0.036	0.005
150	3	6	2	4	6	21	0.016	0.012	0.006	0.022	0.079	0.017	0.004
160	1	4	3	3	1	12	0.005	0.008	0.009	0.017	0.013	0.009	0.003
170			1		1	2			0.003		0.013	0.002	0.001
180	1					1	0.005					0.001	0.001
	191	498	328	178	76	1,271	1.000	1.000	1.000	1.000	1.000	1.000	
HOMER:													
40					1	1					0.011	0.000	0.001
50		5	1		5	11		0.026	0.004		0.057	0.011	0.004
60	4	7	5	7	5	28	0.027	0.036	0.019	0.042	0.057	0.026	0.005
70	27	23	18	40	22	130	0.181	0.118	0.068	0.240	0.250	0.113	0.011
80	45	46	42	53	25	211	0.302	0.236	0.158	0.317	0.284	0.220	0.014
90	29	40	64	20	17	170	0.195	0.205	0.241	0.120	0.193	0.204	0.014
100	24	16	44	12	5	101	0.161	0.082	0.165	0.072	0.057	0.121	0.011
110	6	17	35	15	1	74	0.040	0.087	0.132	0.090	0.011	0.110	0.011
120	4	17	29	7	1	58	0.027	0.087	0.109	0.042	0.011	0.083	0.009
130	4	8	17	6	2	37	0.027	0.041	0.064	0.036	0.023	0.053	0.008
140	2	9	5	5	3	24	0.013	0.046	0.019	0.030	0.034	0.032	0.006
150	2	2	2			6	0.013	0.010	0.008			0.007	0.003
160	2	3	4		1	10	0.013	0.015	0.015		0.011	0.012	0.004
170		1		1		2		0.005				0.002	0.001
180													
190				1		1				0.006		0.002	0.002
200		1				1		0.005				0.002	0.001
210													
	149	195	266	167	88	865	1.000	1.000	1.000	1.000	1.000	1.000	

-continued-

Appendix C2. (Page 2 of 2).

Length Class ^a	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
SEWARD:													
40			1		1	2			0.005		0.009	0.003	0.002
50	3	13	14	13	2	45	0.036	0.080	0.066	0.086	0.017	0.062	0.009
60	10	43	41	31	2	127	0.119	0.264	0.192	0.205	0.017	0.174	0.014
70	31	49	59	26	7	172	0.369	0.301	0.277	0.172	0.060	0.236	0.016
80	6	36	36	23	43	144	0.071	0.221	0.169	0.152	0.368	0.198	0.015
90	13	7	16	27	38	101	0.155	0.043	0.075	0.179	0.325	0.139	0.013
100	8	7	25	20	10	70	0.095	0.043	0.117	0.132	0.085	0.096	0.011
110	4	4	6	5	9	28	0.048	0.025	0.038	0.033	0.077	0.038	0.007
120	4	1	2	4	2	13	0.048	0.006	0.009	0.026	0.017	0.018	0.005
130	2	1	8			11	0.024	0.006	0.038			0.015	0.005
140	2	1	3	2	3	21	0.024	0.006	0.014	0.013	0.026	0.015	0.005
150	1		1			2	0.012		0.005			0.003	0.002
160		1	1			2		0.006	0.005			0.003	0.002
170													
180													
190													
	84	163	213	151	117	728	1.000	1.000	1.000	1.000	1.000	1.000	
VALDEZ:													
30													
40		1	4		3	8		0.006	0.015		0.061	0.011	0.004
50	1	4	5	3	3	16	0.011	0.023	0.019	0.021	0.061	0.022	0.006
60	8	15	24	12	2	61	0.086	0.088	0.092	0.086	0.041	0.086	0.010
70	8	25	38	18	4	93	0.086	0.146	0.146	0.129	0.082	0.130	0.013
80	14	42	50	22	2	130	0.151	0.246	0.192	0.157	0.041	0.182	0.014
90	23	31	40	19	7	120	0.247	0.181	0.154	0.136	0.143	0.168	0.014
100	10	16	37	24	5	92	0.108	0.094	0.142	0.171	0.102	0.129	0.013
110	7	15	20	11	10	63	0.075	0.088	0.077	0.079	0.204	0.088	0.011
120	6	8	13	15	4	46	0.065	0.047	0.050	0.107	0.082	0.065	0.009
130	4	4	14	7	3	32	0.043	0.023	0.054	0.050	0.061	0.045	0.008
140	6	4	8	5	3	26	0.065	0.023	0.031	0.036	0.061	0.036	0.007
150	4	5	4	3	3	19	0.043	0.029	0.015	0.021	0.061	0.027	0.006
160			1			1			0.004			0.001	0.001
170	1		1			2	0.011		0.004			0.003	0.002
180	1	1		1		3	0.011	0.006		0.007		0.004	0.002
190													
200													
210			1			1			0.004			0.001	0.001
	93	171	260	140	49	713	1.000	1.000	1.000	1.000	1.000	1.000	

^a Lower limits of 10 cm length classes (e.g. 40 = 40.0-49.9 cm)

Appendix C3. Observed frequencies and proportions (p) of female halibut harvested by sport anglers each month at Kodiak, Homer, Seward, and Valdez in 1993.

Port	Month	Number of Fish			Proportion Females ^a	
		Female	Male	Unknown	p	SE(p)
Kodiak	May	158	28	7	0.849	0.026
	Jun	445	54	18	0.892	0.014
	Jul	257	64	11	0.801	0.022
	Aug	156	17	5	0.902	0.022
	Sep	71	5	7	0.934	0.027
	Total	1,087	168	48	0.866	0.009
Homer	May	121	25	3	0.829	0.031
	Jun	162	30	3	0.844	0.026
	Jul	203	50	15	0.802	0.024
	Aug	112	42	13	0.727	0.034
	Sep	67	20	1	0.770	0.045
	Total	665	167	35	0.799	0.014
Seward	May	55	29	0	0.655	0.052
	Jun	88	75	0	0.540	0.039
	Jul	119	96	3	0.553	0.034
	Aug	86	62	5	0.581	0.040
	Sep	49	61	7	0.445	0.046
	Total	397	323	15	0.551	0.018
Valdez	May	82	3	11	0.965	0.019
	Jun	145	15	11	0.906	0.022
	Jul	195	58	15	0.771	0.026
	Aug	116	22	4	0.841	0.031
	Sep	28	14	7	0.667	0.067
	Total	566	112	48	0.835	0.014

^a The proportion of females was computed using only fish of known sex.

Appendix C4. Observed number and estimated proportion (p) of angler-days fished and halibut harvested by fishery and ADF&G statistical area in southcentral Alaska, 1993.

Stat Area	Angler-Days			Halibut Harvest		
	Number	p	SE(p)	Number	p	SE(p)
KODIAK:						
525731	60	0.049	0.006	66	0.064	0.008
525732	131	0.106	0.009	83	0.080	0.008
525733	1,023	0.828	0.011	874	0.845	0.011
525805	21	0.017	0.004	11	0.011	0.003
	1,235			1,034		
HOMER:						
515901	18	0.012	0.003	0	0.000	0.000
515902	6	0.004	0.002	0	0.000	0.000
515903	13	0.009	0.002	13	0.007	0.002
515904	81	0.056	0.006	140	0.073	0.006
515905	279	0.192	0.010	446	0.232	0.010
515906	12	0.008	0.002	5	0.003	0.001
515907	61	0.042	0.005	38	0.020	0.003
515908	34	0.023	0.004	9	0.005	0.002
515931	15	0.010	0.003	16	0.008	0.002
515932	24	0.017	0.003	5	0.003	0.001
515933	22	0.015	0.003	2	0.001	0.001
515934	4	0.003	0.001	3	0.002	0.001
515935	55	0.038	0.005	8	0.004	0.001
515936	80	0.055	0.006	82	0.043	0.005
515937	51	0.035	0.005	45	0.023	0.003
515938	6	0.004	0.002	12	0.006	0.002
515939	6	0.004	0.002	3	0.002	0.001
525836	84	0.058	0.006	121	0.063	0.006
525837	26	0.018	0.003	11	0.006	0.002
525901	33	0.023	0.004	36	0.019	0.003
525902	330	0.227	0.011	585	0.305	0.011
525931	202	0.139	0.009	328	0.171	0.009
525932	10	0.007	0.002	13	0.007	0.002
	1,452			1,921		
SEWARD (Civilian):						
485935	335	0.223	0.011	318	0.282	0.013
485933	198	0.132	0.009	168	0.149	0.011
496001	6	0.004	0.002	0	0.000	0.000
495938	441	0.293	0.012	233	0.207	0.012
496002	30	0.020	0.004	5	0.004	0.002
495932	194	0.129	0.009	83	0.074	0.008
495937	1	0.001	0.001	0	0.000	0.000
495936	17	0.011	0.003	2	0.002	0.001
495935	4	0.003	0.001	1	0.001	0.001
495934	30	0.020	0.004	12	0.011	0.003
505932	48	0.032	0.005	35	0.031	0.005
485931	21	0.014	0.003	21	0.019	0.004
485934	19	0.013	0.003	5	0.004	0.002
495939	37	0.025	0.004	46	0.041	0.006

-continued-

Appendix C4. (Page 2 of 2).

Stat Area	Angler-Days			Halibut Harvest		
	Number	p	SE(p)	Number	p	SE(p)
SEWARD (Civilian, cont.):						
495931	6	0.004	0.002	9	0.008	0.003
485932	32	0.021	0.004	51	0.045	0.006
475934	84	0.056	0.006	137	0.122	0.010
	1,503			1,126		
SEWARD (Military):						
485935	1,746	0.214	0.005	1,927	0.336	0.006
485933	132	0.016	0.001	64	0.011	0.001
496001	109	0.013	0.001	110	0.019	0.002
495938	738	0.091	0.003	216	0.038	0.003
496002	68	0.008	0.001	3	0.001	0.000
495932	4,525	0.556	0.006	3,147	0.549	0.007
495937	14	0.002	0.000	28	0.005	0.001
495936	118	0.014	0.001	10	0.002	0.001
495935	71	0.009	0.001	4	0.001	0.000
495934	423	0.052	0.002	164	0.029	0.002
505932	52	0.006	0.001	0	0.000	0.000
485931	20	0.002	0.001	17	0.003	0.001
495902	41	0.005	0.001	16	0.003	0.001
485932	87	0.011	0.001	25	0.004	0.001
	8,144			5,731		
VALDEZ:						
466001	51	0.031	0.004	85	0.050	0.005
466002	118	0.073	0.006	191	0.111	0.008
466003	172	0.106	0.008	230	0.134	0.008
466004	128	0.079	0.007	175	0.102	0.007
466005	90	0.055	0.006	167	0.097	0.007
466031	62	0.038	0.005	49	0.029	0.004
466032	172	0.106	0.008	178	0.104	0.007
466033	256	0.157	0.009	102	0.059	0.006
466100	192	0.118	0.008	27	0.016	0.003
476001	6	0.004	0.002	12	0.007	0.002
476002	44	0.027	0.004	79	0.046	0.005
476003	21	0.013	0.003	39	0.023	0.004
476007	45	0.028	0.004	54	0.031	0.004
476008	99	0.061	0.006	151	0.088	0.007
476009	5	0.003	0.001	10	0.006	0.002
476031	40	0.025	0.004	51	0.030	0.004
476032	30	0.018	0.003	38	0.022	0.004
476033	7	0.004	0.002	7	0.004	0.002
476034	38	0.023	0.004	37	0.022	0.004
476035	49	0.030	0.004	30	0.017	0.003
486002	2	0.001	0.001	3	0.002	0.001
	1,627			1,715		